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PENNSYLVANIA GEOLOGY

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VOL 1/1

THE PENNSYLVANIA GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
Raymond P. Shafer, Governor

STATE PLANNING BOARD
Irving Hand, Executive Director

CONTENTS

The State Geologist Reports 1
The Pennsylvania Geological Survey 2
A Closer Look 4
34th Annual Field Conference 9
Earth Science Teachers Corner 10
Survey Announcements 12
New Survey Publications 15
Calendar of Events 16

on the cover — The Old Museum Building which houses the Harrisburg Offices of the Pennsylvania Geological Survey. Photo by the Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

PENNSYLVANIA GEOLOGY — a publication focused on geology and the earth sciences.

This magazine will feature the work of the Pennsylvania Geological Survey and others active in the field of geology and the allied earth sciences. It will be used to highlight current projects, to make the latest geological information available to the public, and to announce our new publications.

We welcome your suggestions and contributions and hope that you will comment on our new magazine.

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

The Pennsylvania Geological Survey is pleased to present its new magazine. With this publication we aim to share with our fellow citizens the activities and services of the Pennsylvania Geological Survey, as well as other significant and newsworthy developments in the broad field of geology and earth sciences.

With a history dating back to 1836, the Survey is proud of its tradition and its record of accomplishments. Today, with a staff of 25 highly competent, professional geologists, the Pennsylvania Geological Survey is engaged in broad programs of geologic and topographic activities designed to serve the present and future needs of Pennsylvania and its citizens. This first issue of the magazine introduces the major divisions of the Survey's programs; future issues will further define the activities and will give detailed accounts of the objectives and progress of individual projects being conducted by the Survey.

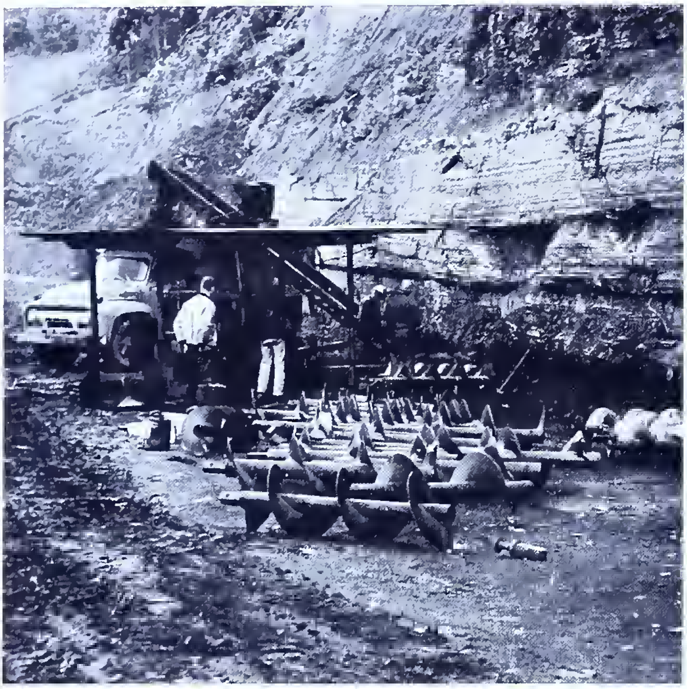
The Pennsylvania Geological Survey is engaged in many projects of basic geologic mapping, numerous mineral resource investigations, extensive groundwater studies, and widespread topographic mapping. Geology is a dynamic subject, with new scientific techniques and awareness. So, too, the Geologic Survey must be dynamic and alert to new needs and new geologic challenges in Pennsylvania. We are pleased to note that geology is being recognized more and more as playing a vital role in man's daily life, controlling man's physical environment, and affecting his planning and his economic development. The Survey is striving to meet this increased use of geology through projects aimed at serving the needs of the many new users as well as a vigorous effort to effectively communicate its geologic findings. Thus, we see to it that the results of every project and every investigation are published and made public.

This magazine is another step in our program of communication. We shall strive to keep it meaningful. The birth of a new magazine is always an auspicious occasion. While the Pennsylvania Geological Survey has an extensive record of geological publications to its credit, this is our first attempt at a regular "newsy" magazine. We hope to make it a magazine of significant content, yet pleasantly readable. We shall always welcome your comments and suggestions, and by all means, we invite you to submit any geologic items which will be of interest to Pennsylvanians.

Arthur A. Socolow

THE PENNSYLVANIA GEOLOGICAL SURVEY

133 years of service....



to industry,

to government agencies,

to students,

to fellow geologists,

and to the individual.

A closer look at the SURVEY . . . .

In order to function efficiently, the Pennsylvania Geological Survey has several divisions, each working on specific projects and requests, but all working together for a better geological understanding of the Commonwealth. These divisions are the Field Geology Division, the Mineral Resources Division, the Environmental Geology Division, and the Oil and Gas Division.

The following article briefly describes the functions of the divisions and the specific projects currently in progress. Hopefully, from this you will gain a better understanding of the work of the Survey. A listing of the Survey staff appears on the inside of the back cover.

FIELD GEOLOGY DIVISION

Since the inception of the First Pennsylvania Geological Survey in 1836, field geologists have gathered the basic data which constitutes the framework of Pennsylvania geology. Today, no less compelling than it was more than a century ago, many of the geologic answers to fundamental problems concerning mineral resources, environmental conditions, and land utilization lie in direct examination of rock in the field rather then laboratory study of collected specimens. In recognition of this truism many of the Survey personnel are engaged in geologic field studies.

Classically, field geologists map the distribution of various rock strata and types in an area. However, this is only the first step towards the goal of understanding the processes and conditions by which the rocks were initially formed and subsequently altered both structurally and chemically. Only when rocks are fully understood in this sense can quantitative prediction be made as to their distribution, geometry, composition, and ultimately their mineral utility and effect upon society.

There are currently five regions in the Commonwealth in which active geologic field work is carried out by staff geologists. These areas have been selected where there is a need for information on the relationship of the rock strata to land use and development, to mineral deposits, and to fundamental geologic problems.

Four field geologists are working in the Clearfield County area on the Appalachian Plateau. Active strip mining there has created many exposures which aid in determining the coal reserves in that region and which relate to problems concerning the formation and distribution of coal and clay. These geologists also collect information and sample rocks at active strip mines throughout the state — invaluable information that is lost as these mines are quickly backfilled.

Two field geologists are working in the mountainous terrain that is characteristic of the Valley and Ridge in Perry and Juniata Counties. Basic information is being obtained concerning the folding processes that created the mountains and the mineral potential of the various rock strata. This information will supplement geologic data required by urban centers in this region.

In the Pocono Plateau area in Monroe and Carbon Counties, two field geologists are engaged in a variety of studies. These include studies on the origin and economic geology of flagstone deposits, sand and gravel from glacial deposits, refractory sand from consolidated strata, and possible oil and gas deposits. In addition, the surficial and bedrock geologic map being compiled in this project has great utility in the planning of both urban and recreation development of this region.

Two field geologists, one working in Franklin County and the other working in Berks County, are engaged in an associated project. This project includes mapping the distribution of and studying the high calcium and cement limestones of the Great Valley. The economic mineral potential of the associated dolomites and shales is also being studied but to a lesser degree. In the course of these studies much was learned concerning the complex geologic history of these ancient mountains. The more accurate geologic maps produced as a consequence are useful in resolving the geologic problems associated with this heavily urbanized area.

The field geology program is augmented by cooperative U.S. Geological Survey geologists. Several U.S.G.S. geologists are studying the coal, clay, and sand deposits of southwestern Pennsylvania, and compiling land utilization maps derived from their geologic maps. Another geologist is working in the Valley and Ridge area in Bedford County supplementing work done by our staff geologists. In the Pocono Plateau a U.S.G.S. geologist is working in cooperation with staff geologists and studying slate and clay deposits in conjunction with his basic field geology studies.

The field geology program is further supplemented by a number of contractual geologists who undertake specific short term projects. These projects usually supplement the more comprehensive studies of one of the field geology groups. The contractual geologists are frequently professors of geology from a major university.

MINERAL RESOURCES DIVISION

The work of the Mineral Resources Division encompasses several functions. As a service unit, the division performs laboratory identification and analyses of rocks and minerals for all the Pennsylvania Geological Survey ongoing investigations, for state and cooperating federal agencies, and for the public – whether as individuals or groups. The public services are provided free upon request within the limits of the Survey's facilities and the available staff time. In this division, geological investigations and services are performed within the rock preparation laboratory, the microscopic and petrographic laboratory, the photographic laboratory, the X-ray analysis laboratory, a semi-quantitative chemistry laboratory, and with the use of a variety of equipment ranging from simple binocular microscopes to complex X-ray diffraction and spectrographic instruments. Besides the maintenance of these laboratories and the services connected with them, each division member is engaged in one or more geological research projects, the function of which is to contribute to our understanding of Pennsylvania geology, particularly the geologic resource potentials in the state.

One of the most important projects in the Mineral Resources Division is a study of the potential uses of Pennsylvania's clays and shales. This project began in 1962 and is under continued investigation. The shale–clay project, in cooperation with the United States Bureau of Mines, includes the geology, chemistry, mineralogy, physical properties, and fired characteristics of clay and shale materials that could be utilized by such industries as refractory brick manufacturers, producers of lightweight aggregate, brick, and stoneware products.

Another major project has been the study of the Cornwall, Pennsylvania magnetite ore deposits, a major producer of iron ore with copper, gold, silver, cobalt, and limestone by-products. This research, now nearing publication, has emphasized the understanding of the origin of the ores with a view to determining methods for searching out new magnetite deposits and extending the reserves of known occurrences.

The Survey's program of coal research has been extended by the Mineral Resources Division to include chemical analysis data from strip mines which will yield information on power potential, pollution of air and ground water by sulfur, and a fundamental knowledge of the stratigraphy of coal and related sedimentary rocks.

Another ongoing project is a study of the crushed rock materials that are used in highway surface construction. This study involves both geology and laboratory testing and is being conducted in cooperation with the Pennsylvania Department of Highways, The Pennsylvania State University, and the Stone Producers Association of Pennsylvania. The project has been initiated to improve skid resistance in the hope of reducing traffic accidents on our congested highways.

In southern Lancaster County, a study is in progress that deals with serpentinites and metamorphic sedimentary rocks. The purpose of this project is to produce a map of the rock types in the area, to understand their structure and origin, and to assess economic potential, particularly with regard to serpentinite for crushed stone, chromite (an ore of chromium), magnesite (a source of magnesium), and talc.

In addition to these major projects many smaller research and service studies are underway. These include the publication of an industrial directory, information on mineral collecting localities, compilation of Pennsylvania's mineral resources, studies of Precambrian geology, a summary of the structural geology of the Triassic basin, a study of diabase dikes, and a summary of radiometric age dates of Pennsylvania rocks. Many of these projects are being carried out in conjunction with geologists from other divisions of the Survey.

ENVIRONMENTAL GEOLOGY DIVISION

The Pennsylvania Geological Survey recently established a Division of Environmental Geology. One of the primary goals of this new unit is to assist and advise government, industry, and the general public about the many geologic reports, maps, illustrations and other analyses which have been and are currently being developed by the Pennsylvania Geological Survey.

Planning on the municipal, county, and regional levels has demonstrated a great need for the description and interpretation of the physical features of an area. The Environmental Geology Division is particularly working to assist planning agencies in making use of geologic information such as engineering geology, mineral resources, topography, ground water, and many others, for more effective planning of all types of construction and land use projects.

Current projects of the Environmental Geology Division include a report entitled "Geology in Land-Use Planning." The importance of geology in land-use planning is emphasized. The geologic environment, including topography, general geology, engineering geology, water resources, and mineral resources are presented to the planner with the use of many photographs and sketches. Each of these factors is stressed in relation to data the planner needs, its uses, and examples of how this data can benefit him. The text closes with a summary of all geologic factors that should be used in evaluating land use, emphasizing how geology should be employed in planning, designating, and developing land use.

A new map showing the limestone and dolomite distribution in Pennsylvania has recently been released. An index of all Pennsylvania Geological Survey publications pertaining to carbonate rocks is keyed to the distribution map. A short text outlining the potential hazards of a limestone terrane, and the mineral resources and ground-water value is presented on the reverse side of the map. Specific areas in Pennsylvania are especially hazardous. The need for knowing this information is also outlined.

A third project concentrates on the engineering characteristics of the rocks of Pennsylvania. Each rock formation in Pennsylvania will be evaluated for bedding characteristics, jointing, faulting, folding, cleavage, depth to bedrock, depth of weathering, excavation characteristics, ease of excavation, type of construction material available, depth to water table, ground-water yield characteristics, active and abandoned oil and gas fields, topography, stability of rock slopes, landslide potential, and many others.

Computerization of Pennsylvania's water well data describes one of the newest projects of this division. Currently, water well data are available on well completion reports submitted to the Survey by the Commonwealth's licensed water well drillers. These data are to be transferred to coded well schedule sheets and computer cards will be punched from them. No publication will result but the information will be available to everyone.

As part of the Survey's continuing educational program, important geologic features in Pennsylvania's State Parks are being highlighted in a new series — Pennsylvania's Trail of Geology. A separate geologic park guide will be prepared for each state park in Pennsylvania. This guide will outline in general the geology of the park and specifically emphasize any and all important geologic features. Each guide will be written in a simple, informative style, easily read by the layman. It will be illustrated with photographs and sketches. A small geologic map or index map will be included in each guide. The first three guides, Archbald Pothole State Park, Hickory Run State Park and Trough Creek State Park have been released and are available at the state parks or upon request from the Survey.

OIL AND GAS DIVISION

The Oil and Gas Division has the primary task of providing applied research studies of the hydrocarbon resources of Pennsylvania. The basic subsurface geology described and studied by the staff of this division can be widely used outside of the confines of petroleum geology and engineering. This applied research is very important in ground-water evaluation, salt exploration, ground-water pollution, deep well waste disposal and other subsurface storage such as natural gas and potable water.

In addition to the research studies, this division collects, compiles and makes usable to industry, to the general public, and to government such important tabulations as well data cards, well sample descriptions, fluid analyses, core analyses, grain-size analyses, drilling and production statistics, well sample and core library, geophysical log file and unpublished oil and gas maps.

Current projects include the revision of the mineral resource report on crude oil reserves in Pennsylvania and also the pipeline map showing oil and gas pipelines in the Commonwealth. A "Guide to the Geology of the Pittsburgh Area" has been completed and will be published in the near future.

Compilations of deep and shallow formations and brine analyses have been completed and will be made available to the public either on open file or as a publication.

One of the newest projects is a subsurface disposal study which will define the critical and limiting conditions for disposal in subsurface reservoirs.

New base maps showing the location of oil and gas wells drilled since the Oil and Gas Laws of 1956 are currently in preparation.

34th ANNUAL FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS

Oct. 2-4, 1969

THE POCONO FORMATION IN NORTHEASTERN PENNSYLVANIA

The Pocono Formation in northeastern Pennsylvania is a magnificent series of white sandstones, conglomerates, and dark shales. Called Vespertine by H.D. Rogers, State Geologist of the First Pennsylvania Geological Survey and renamed Pocono by J.P. Lesley, State Geologist of the Second Pennsylvania Geological Survey, the unit became the focus of a literary controversy known as 'the Pocono problem.' The rocks comprising the main body of the Pocono have seldom been in doubt, but definitions of the base of the unit range from the Catskill-Pocono transition zone of H.D. Rogers and I.C. White to the angular unconformity of J.P. Trexler, G.H. Wood, and H.H. Arndt. Long considered a body of terrestrial deposits, recent reports by W.D. Sevon indicate that part of the northeastern Pocono is in reality subaqueous in origin. B. Willard, A.D. Leonard, and J.D. Glaeser have all heralded marked alterations of the aerial distribution of the Pocono in northeastern Pennsylvania.

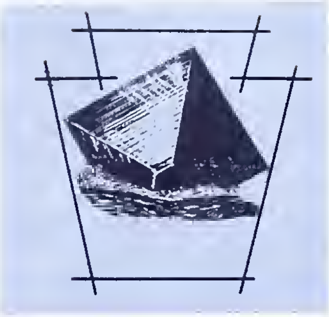
Therefore, the purpose of this conference will be to demonstrate, in the field, the various aspects of the Pocono Formation in northeastern Pennsylvania and to unify the Pocono as a consistent sedimentological assemblage. Hopefully the conference will clarify many aspects of Pocono geology and will stimulate further research on the formation throughout Pennsylvania.

The conference will be held on October 3 and 4, 1969, and will be centered in Hazelton, Pennsylvania. The field trip will be preceded on the evening of October 2 by an illustrated talk about the Pocono Formation in northeastern Pennsylvania.

The first day of the trip will emphasize the stratigraphy and sedimentology of the Pocono Formation. The main stops will be the type locality of the Pocono at Jim Thorpe (formerly Mauch Chunk) and four other diverse stops in the upper part of the Lehigh River gorge between Jim Thorpe and White Haven.

The second day of the field trip will demonstrate the lateral variation and sedimentological consistency of the Pocono Formation. Stops will be along the margins of the Lackawanna-Wyoming Basin.

Pre-registration announcements are being sent to our regular field conference mailing list. If you do not receive an announcement and wish to attend the conference contact Dr. Arthur A. Socolow, the Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.



EARTH SCIENCE TEACHERS' CORNER

PENNSYLVANIA GEOLOGY replaces many individual newsletters, bulletins, and news releases. One of those replaced is the Earth Science Teachers' Newsletter. This magazine will include items for educators in the Earth ScienceTeachers' Corner, and it is hoped that you will also find articles of interest in the rest of the magazine.

NEW FIELD TRIP GUIDE AVAILABLE

A field trip guide to Fayette County, Pennsylvania, has been prepared by John Tomikel in conjunction with the Sixteenth Annual Spring Conference of the Pennsylvania Council for Geography Education held last Spring near Uniontown. The guide is divided into two parts; the first pertaining to the settlement patterns in rural Fayette County and the second to the geology of the county.

This field trip guide is available from Dr. John Tomikel, Department of Earth Sciences, California State College, California, Pennsylvania, 15419, for $1.00 plus postage.

IN-SERVICE INSTITUTE IN EARTH SCIENCE

The Pennsylvania State University, the Ogontz Campus in Abington, Pennsylvania, has received a grant from the National Science Foundation to offer two courses for six graduate credits to junior and senior high school teachers within commuting distance of the Ogontz Campus. Teachers with a minimum of three years of experience who are interested in acquiring the skills and knowledge necessary to teach the Earth Science Curriculum Project (ESCP) approach should apply immediately.

The courses cover background information in Earth Science and practical experience in the investigations developed by the Earth Science Curriculum Project.

Requests for applications should be addressed to: Prof. Peter C. Bazakas, Director, In-Service Institute in Earth Science, The Pennsylvania State University, The Ogontz Campus, 1600 Woodland Road, Abington, Pa., 19001. Telephone: TU6-9400, Ext. 208.

EDUCATIONAL SERIES

Two new booklets in the Educational Series of the Survey are now available – ES 7, **Coal in Pennsylvania** and ES 8, **Geology of Pennsylvania's Oil and Gas**. Free copies may be obtained by writing to the Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

PENNSYLVANIA LEADS NATION

William H. Bolles, *Earth and Space Science Advisor, Bureau of General and Academic Education, Pennsylvania Department of Education*

The Commonwealth of Pennsylvania leads the nation in secondary student enrollment in Earth and Space Science. During the 1967-68 school year 108,000 students were enrolled among approximately 720 secondary schools. This is the highest Earth and Space Science enrollment among the 50 states.

Prior to the publishing of the Earth and Space ScienceTeaching Guide in 1958, there were 800 students receiving instruction in the earth sciences in 9 schools in Pennsylvania.

The tremendous growth of the Pennsylvania Earth and Space Science program can be accounted for in a number of ways. The introduction of the teaching guide came at a time when teachers were becoming increasingly dissatisfied with the superficial treatment of science offered by general science texts. The willingness of colleges and universities throughout the State to introduce teacher training programs in the earth sciences also provided the impetus for increased success. Organizations such as the American Geological Institute, in sponsoring the Duluth Conference out of which developed the Geology and Earth Sciences Sourcebook, the National Science Foundation through the Summer Institutes, In-Service Institutes, and Academic Year programs, and the Pennsylvania Geological Survey, which provided materials such as their educational series of publications, rock and fossil kits for teachers and group leaders, and assistance to school districts in the form of lecturers and consultative help, all served to stimulate interest among teachers and students.

At the near peak of Pennsylvania enrollment, national interest in the earth sciences was generated by the NSF funding of the AGI sponsored Earth Science Curriculum Project which was pilot tested in 10 schools in Pennsylvania. The somewhat late availability of the final edition of ESCP for the 1967-68 school year resulted in only 8,000 students taking the ESCP course. This figure has climbed to 36,000 students during the 1968-69 school year.

The Earth and Space Science Teaching Guide is being completely rewritten by a committee consisting of several members of the original writing committee together with secondary school teachers. The new guide is expected to be available early in 1970.

SURVEY ANNOUNCEMENTS

NEW COOPERATIVE COAL—TESTING PROGRAM

The Pennsylvania Geological Survey has established a cooperative agreement with the Pittsburgh Regional Office of the U.S. Bureau of Mines for extensive analysis of Pennsylvania coals.

The Survey is systematically mapping and sampling the various coal resources of the Commonwealth and is making careful notations of the geologic conditions and properties of the coal beds. The U.S. Bureau of Mines has agreed to conduct proximate analyses on the coal samples, thus yielding data on the content of volatile matter, moisture, ash, and sulfur in the coals.

The combined comprehensive study of the geologic conditions and chemical analyses of the coals should help to stimulate the consumption of Pennsylvania coals for various uses having specific and limited physical-chemical needs. The results of this study will also aid the coal industry to more efficiently develop as well as conserve Pennsylvania's valuable coal resources.

OIL AND GAS INDUSTRY ACTIVITY

On the basis of well records received by the Department of Mines and Mineral Industries, oil and gas industry activity during the first five months of 1969 is slightly above the comparable period last year. Successfully completed primary shallow oil and gas wells are up as well as secondary oil recovery and gas storage well completions. Although shallow highlight wells, those completed in excess of 50 BOPD and 2 MMCFGPD, have increased proportionally, dry holes have slightly decreased. Deep horizon drilling and completions, however, have not paralleled the advance in shallow well activity.

Although deep drilling decreased, the potential for discovery of significant new deep horizon reserves of gas in western Pennsylvania has received impetus from recent Cambro-Ordovician discoveries in eastern Ohio within 15 miles of the state line. Subsurface conditions for entrapment of gas in this interval appear to be at least as favorable in southwestern Pennsylvania.

SURVEY BASE MAP PROGRAM

The Pennsylvania Geological Survey has established scale, format, and procedure for the preparation and release on request of base maps showing the location of all oil and gas wells drilled since the Oil and Gas Laws of 1956, as well as areas of extensive pre-law field development in western Pennsylvania. Each map will encompass an area including four 15-minute topographic quadrangles. Deep and shallow horizon wells will be differentiated, depth of penetration indicated, well status illustrated and availability of well data other than permits and records shown. A few map areas will be available for distribution on request at a nominal fee by the end of the year. An announcement of availability will be made later this year.

GEOLOGICAL RESEARCH IN PENNSYLVANIA

The "Thirteenth Annual Newsletter of Geological Research in Pennsylvania" has been compiled by the Pennsylvania Geological Survey as an information service to all individuals using geological information in the State.

The research listings are grouped into categories to facilitate your search for information in a particular field. A list of publications printed during 1968 and early 1969 and a list of publications known to be in press are included.

Copies of the newsletter may be obtained by writing to the Bureau of Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

SURVEY PARTICIPATES IN NEW TOWN STUDY

In recognition of the fact that geology is a basic, controlling factor in the planning and development of any new community, the Pennsylvania Geological Survey is actively participating in the development of data for the area near New Stanton, Pennsylvania, where a burgeoning population growth is expected in conjunction with the new Chrysler Corporation assembly plant.

The Survey has developed data on the distribution of the various rock types and their physical properties, the occurrence of mineral resources which may affect land use, and the nature and distribution of available subsurface water.

This data will be incorporated in a broad planning program for the area being sponsored by the State Planning Board. The Survey's participation in the program helps demonstrate the importance of geology in land—use planning.

IMPORTANT NEW LAND USE PUBLICATION

The Pennsylvania Geological Survey has just released a significant new publication entitled "Geology and Land Use in Eastern Washington County, Pennsylvania." The report is a result of the cooperative program between the Pennsylvania Geological Survey and the United States Geological Survey and was written by B.H. Kent, S.P. Schweinfurth, and J.B. Roen. In demonstrating that geology has a direct effect and control on the use and development of land by man, they describe the composition, structure, and present condition of the bedrock in eastern Washington County. A brief discussion of how the rocks and rock layers react to natural forces and processes that continue to act upon them, to form contact springs and landslides, and to create engineering and construction problems is provided.

The lithologic maps and generalized lithologic columns that accompany the report show the general distribution, thickness, and variation of each of the principal coal beds and sandstone and limestone units which are at or near the ground surface within the mapped area. On the lithologic maps, the structure of the bedrock is outlined by structure contours drawn on the base of the Pittsburgh coal bed.

The report also includes more specific information, such as analytical and laboratory test data on representative samples of sandstone, limestone, coal, mudstone, claystone, and landslide material, and includes calculated reserves of Waynesburg coal within the mapped area. An index map showing the status of recent lithologic and geologic mapping in southwestern Pennsylvania is also provided.

Washington County borders the Pittsburgh metropolitan area, one of the major population and industrial centers in the United States. Within the next 10 years, much of what is now rural farmland within the county probably will be converted and subdivided to meet the needs of increasing population and industrial expansion. There appears to be no limit to this projected growth but there is a definite limit to the amount of land available, and land uses and land-use problems will therefore become increasingly critical. Rocks and geologic conditions may be either the cause of such problems or the means of resolving them, and geologic studies are most effective during the early stages of land-use planning, before land is committed and construction begins.

SURVEY INITIATES DISPOSAL WELL STUDY

Increased concern about pollution abatement on the surface has been accompanied by added industrial interest in the disposal of waste effluents into subsurface reservoirs. Since the limiting factors for such disposal are chiefly geological, the Pennsylvania Geological Survey has initiated a project to define the critical and limiting geological conditions. Disposal principles and guidelines will be stressed so that the public, industry, and government can better evaluate each proposal.

NEW SURVEY PUBLICATIONS

The following list of publications has been released by the Survey during the past few months. All of these publications are available at the Capitol Book Store, 10th and Market Streets, Harrisburg, Pennsylvania, 17125, except Information Circular 63 which is available free of charge from the Survey. Checks should be made payable to the Commonwealth of Pennsylvania. For Pennsylvania addresses, please add 6% State Sales Tax.

Publication			*Price*
A	37	(Reprint) **Mineral Resources of the Greensburg Quadrangle, Westmoreland County, Pennsylvania,** by M.E. Johnson (162 p., 25 fig., and 13 pl.).	$6.00
A	54	(Reprint) **Geology and Mineral Resources of the Brookville Quadrangle, Pennsylvania,** by C.K. Graeber, R.M. Foose, and M.N. Shaffner (136 p., 14 fig., and 16 pl.).	7.00
A	65	(Reprint) **Geology and Mineral Resources of the Punxsutawney Quadrangle, Pennsylvania,** by G.H. Ashley (145 p., 26 fig., and 6 pl.)	7.50
A	75	(Reprint) **Geology and Mineral Resources of the Curwensville Quadrangle, Pennsylvania,** by G.H. Ashley (140 p., 32 fig., and 4 pl.).	6.00
A	178	(Reprint) **Geology and Mineral Resources of the New Holland Quadrangle, Pennsylvania,** by Anna I. Jonas and G.W. Stose (40 p. and 7 pl.).	3.50
G	56	**Geology and Land Use in Eastern Washington County, Pennsylvania,** by B.H. Kent, S.P. Schweinfurth, and J.B. Roen (31 p., 3 fig., 5 tab., and 2 pl.).	2.75
IC	60	**Devonian Tully Limestone in Pennsylvania and Comparison to Type Tully Limestone in New York,** by Philip Heckel (33 p., 4 fig., 3 tab., and 1 pl.).	.50
IC	61	**Revised Lithostratigraphic Nomenclature of the Pottsville and Allegheny Groups (Pennsylvanian) Clearfield County, Pennsylvania,** by William E. Edmunds (36 p. and 14 fig.).	.50
IC	62	**The Precambrian in the Subsurface of Northwestern Pennsylvania and Adjoining Areas,** by Timothy E. Saylor (25 p., 6 fig., 5 tab., and 2 pl.).	.45

Publication			*Price*
IC	63	**The Mineral Industry of Pennsylvania in 1967,** by Charles C. Yeloushan (37 p., 1 fig., and 10 tab.).	Free
M	50	Part 2-B, **Economics of Pennsylvania's Clay and Shale Production,** by George F. Deasy and Phyllis R. Griess (25 sheets with 79 maps).	1.00
M	59	**Geology of the Elk Run Gas Pool, Jefferson County, Pennsylvania,** by Louis Heyman (18 p., 4 fig., and 2 pl.).	.50
M	60	**Medina and Oriskany Production along the Shore of Lake Erie, Pierce Field, Erie County,** by Dana R. Kelley and William G. McGlade (38 p., 6 fig., and 4 pl.).	2.40
PR	176	**Geology of a Portion of the Allensville Quadrangle, Centre and Huntingdon Counties, Pennsylvania,** by Linda L. Flueckinger (1 sheet containing geologic map, stratigraphic column, and text).	2.20
W	24	**Geology and Hydrology of the Martinsburg Formation in Dauphin County, Pennsylvania,** by Louis D. Carswell, Jerrald R. Hollowell, and Lucian B. Platt (54 p., 17 fig., 3 tab., and 1 pl.).	2.30
W	25	**Hydrology of the Metamorphic and Igneous Rocks of Central Chester County, Pennsylvania,** by Charles W. Poth (84 p., 29 fig., 6 tab., and 3 pl.).	4.50

Calendar of Events

Oct. 2-4	34th Annual Field Conference of Pennsylvania Geologists, Hazleton, Pennsylvania (For details see page 9).
Oct. 14	The Pennsylvania State University Geological Sciences Seminar — Dr. D. L. Turcotte, Cornell University, "Mantle Convection and the New Global Tectonics."
Oct. 18-22	American Association of Stratigraphic Palynologists, 2nd Annual Meeting. Information from Dr. A. Traverse, Deike 529, University Park, Penna., 16802 Field trip chairman, Dr. Eugene G. Williams, Department of Geology, The Pennsylvania State University.
Oct. 21	The Pennsylvania State University Geological Sciences Seminar — Dr. John F. McCauley, U. S. Geological Survey, "The Geology of the Near Side of the Moon."
Oct. 28	The Pennsylvania State University Geological Sciences Seminar — Dr. A. J. Naldrett, University of Toronto, "Origin of the Sudbury Deposits."

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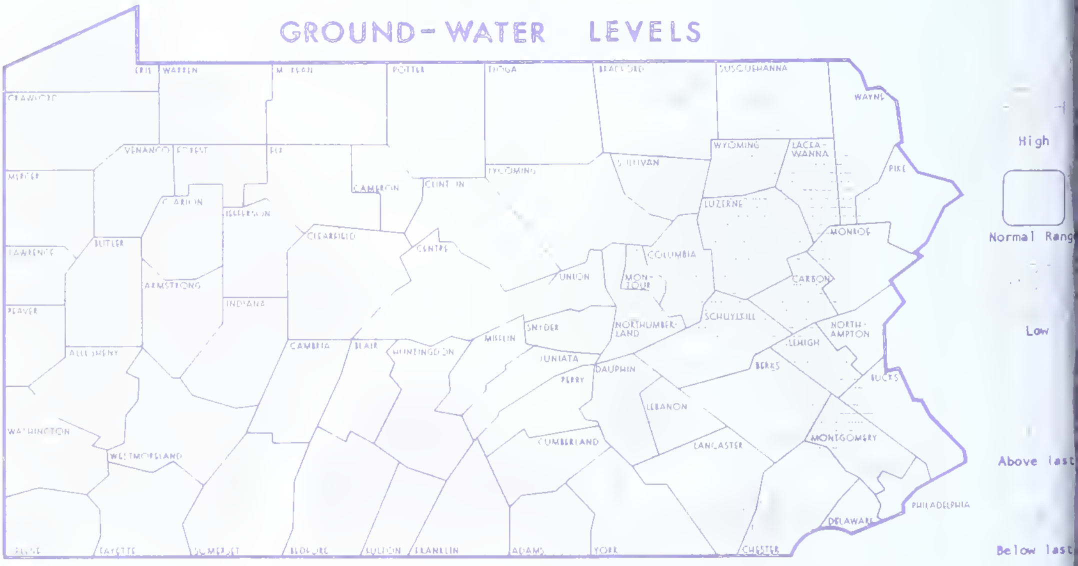

Prepared by WATER RESOURCES DIVISION, U.S. GEOLOGICAL SURVEY, P.O. Box 1107, Harrisburg, Pa. 17108, Phone 717 787-3420, in cooperation with Pennsylvania Department of Forests and Waters, Pennsylvania Topographic and Geologic Survey, and the City of Philadelphia Water Department.

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PENNSYLVANIA GEOLOGY

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THE PENNSYLVANIA GEOLOGICAL SURVEY

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Arthur A. Socolow, State Geologist

CONTENTS

The State Geologist Reports 1
Geology Garden in Allentown 2
Pennsylvania Mineral Industry Gains 3
Susquehanna River Gaps Dedicated 4
DuBois Basin Core Drilling 6
Columnar Jointing in South Mountain 7
Fifty Years of the Fourth Survey 8
Earth Science Teacher's Corner 10
Proposed Lehigh River Gorge State Park 11
Survey Announcements 12
New Survey Publications 15
Northeastern Pennsylvania Field Trip 16
Calendar of Events 16

on the cover — The Susquehanna River at Harrisburg, showing one of the gaps that w
recently dedicated (see page 4). Photo by Grant Heilman.

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OCTOBER 1969

FROM THE DESK OF THE STATE GEOLOGIST . . .

The Apollo moon trip brought the words "geology", and "rocks" before the public as no single event in man's history. More than half a billion people around the world watched on television as the astronauts collected rock samples on the Moon. Millions of people have since eagerly followed radio and press reports on the results of the Moon rock examinations back here on Earth.

As fellow scientists and geologists, we are delighted with the success of the Moon mission and the fascinating results which are unfolding. We particularly hope that the public will have gained not only a fascination for lunar geology, but also a new awareness of what geology means to man on earth.

Those of us who daily work on geologic problems and investigations here on Earth know only too well that there remains so very much geologic work yet to be done on Earth for the well being and continued survival of man.

Man's fast growing population and continually increasing standard of living throughout the world is consuming and demanding ever increasing amounts of mineral resources even as those resources are everywhere becoming more and more difficult to find. The need for more and more energy is taxing the combined resources of coal, oil, gas, and atomic energy – all of which constitute materials coming out of the ground. As man occupies and crowds into the remaining land surface on Earth, he is becoming aware that he needs to know the local geology in order to deal with such matters as foundation problems, adequate water supply, transportation routes, earthquake hazards, agricultural lands, and places to safely dispose sewage and other wastes. Conserving the beauty of our landscape and providing space for recreation also call for geologic aid.

So while the Pennsylvania Geological Survey shares the excitement of the Moon rocks, our work will continue to be down to Earth, with that magnificent portion called Pennsylvania, striving to better the daily life of our citizens through increased knowledge and wise use of our own geologic environment.

Arthur A. Socolow

GEOLOGY GARDEN GROWS IN ALLENTOWN

A unique Geology Garden featuring rocks and minerals from Lehigh County was dedicated recently at the Old Courthouse in Allentown. This garden, designed and built by the Lehigh County Cultural Center, is intended to provide the public with an outdoor educational classroom in the elegance of a garden setting. The Geology Garden designed as a walk through, is a journey through the ages of earth's history with the rocks as guides telling the story of their valuable resources and the influence of these mineral resources on the lives of men. Everywhere you look and step in the garden you are in contact with one of the great mineral assets of Lehigh County. Both rocks and shrubbery have been "planted" here to enable you to explore this world of Lehigh County's rocks and minerals.

PENNSYLVANIA MINERAL INDUSTRY SHOWS GAINS

Newly released figures by the U.S. Bureau of Mines show that Pennsylvania's mineral production increased in 1968 to a production value of $904 million. Major gains were made in cement, stone, copper, clay, iron ore, sand and gravel production.

While coal production was off slightly during the year, the $505 million value accounted for 55 percent of the State's mineral income. Cement was second in importance with 15 percent of the total mineral value, stone accounted for 12 percent while oil and gas yielded $44 million or 5 percent of the total mineral value.

The new mineral production data included facts often overlooked. Pennsylvania's one zinc mine produced over 30,000 tons of contained zinc during the year; 4,850 tons of copper were produced in Pennsylvania last year, and the State's 36,000 tons of peat production makes it one of the Nation's leading producers.

Washington County was the leading mineral producer in the State, with over $80 million of production, mostly coal. Northampton County was a close second with its combined production of cement, stone, slate, and sand and gravel.

Coal data show that 70 percent of production came from underground mines with Washington County the leading producer and Greene County a close second.

During the year, Pennsylvania's 42,500 producing oil wells yielded 4.1 million barrels of oil while the 17,000 producing gas wells yielded 88 billion cubic feet of natural gas. The 922 new oil and gas wells drilled during the year evidences the continual growth, with Warren County leading the way with 238 successful new wells.

Northampton County led in the important cement production followed by Lehigh County. Bucks County was the leading sand and gravel producer, Northampton County the leading stone producer, Centre County the leading lime producer, and Luzerne County the leading peat producer.

Pennsylvania continues to be the leading mineral producer east of the Mississippi River, and the fifth ranking state in the United States.

SUSQUEHANNA RIVER GAPS DEDICATED

The area of five water gaps along the Susquehanna River, north of Harrisburg, was dedicated on September 4, 1969 as a National Natural Landmark. This official designation by the National Park Service is expected to greatly increase the already sizable number of visitors who have been coming to admire the magnificent scenery and fascinating geology which is graphically shown along this stretch of the river.

State Geologist Arthur Socolow, a featured speaker at the dedication ceremonies, praised the formal recognition of this outstanding natural landmark and traced the history of geologic events which brought the area to its present configuration. He noted that about 500 million years ago this region of Pennsylvania was submerged below the sea and then followed 300 million years of accumulation of sands and muds on the sea bottom. Then, 200 million years ago, the thousands of feet of accumulated sediments were uplifted in a great mountain-building upheaval known as the Appalachian Revolution.

Dr. Socolow pointed out that today's geologic measurements indicate that the fold mountains which formed in Central Pennsylvania during that great upheaval were on the order of six miles high, exceeding today's greatest heights in the Himalaya Mountains. There then followed a long period of over 100 million years of erosion which gradually wore down the great mountains until there was left only a flat plain almost at sea level. This quiescent landscape was interrupted some 20 million years ago as the eroded, plain surface was gradually tilted by geologic forces. It was on that tilted surface that the Susquehanna River had its origin millions of years ago, along a course that was governed by the southeastward tilt of the eroded surface and oblivious of the former northeast-trending mountain ridges.

Because the land surface was uplifted as well as tilted, erosion again began to work on the land mass, affecting the various rock formations in relation to their hardnesses. The soft layers, the shales and limestones, have eroded more rapidly and formed today's valleys. The hard layers, sandstones and quartzites, have eroded slowly and formed today's ridges.

Dr. Socolow stressed the fact that the present ridges in Central Pennsylvania are merely the erosional remnants of the former great mountains, while the course of the Susquehanna River cuts across today's ridges because the river began to flow on a flat erosional plain before the present ridges developed by differential erosion. He noted that the geologic record is recorded in the rocks exposed in the five gaps of this newly dedicated natural landmark. Thus, the area serves as a classical exhibit for visiting geologists, as well as a scenic attraction for all lovers of great natural landscapes.

U.S. COAL RESOURCES

The U.S. Geological Survey estimates that U.S. coal resources remaining in the ground total 3,210 billion tons, about half of which is believed to be ultimately recoverable. The U.S. has about 1/5 of the total estimated world coal resources. About 50 percent of U.S. coal resources are known from detailed geologic mapping and studies by the Survey and various state agencies. The remaining resources are inferred to be present in unmapped areas and in deeper parts of larger coal basins. Of known resources: 44.5 percent is bituminous coal; 26.5 percent subbituminous; 27.5 percent lignite; and 1.5 percent anthracite.

A 116-page report, *Coal Resources of the United States, January 1, 1967,* is available from the Supt. of Documents, U.S. Govt. Printing Office, Washington, D.C. 20402, for 65 cents.

DuBois Basin Core Drilling Provides New Coal Data

In June and July of this year, the Pennsylvania Geological Survey drilled four deep core holes to provide information on the nature and economic potential of the deep coals and other strata from one side of the DuBois Basin to the other.

In southeast Jefferson and northwest Clearfield Counties, along the DuBois Basin between Punxsutawney and Penfield, the rocks bearing the major coal seams lie at considerable depth below the ground surface. Very little is known of these deep coals, and, with one exception, they have not been commercially exploited.

Drill hole no. 1 encountered three coal seams over 2 feet thick - lower Kittanning (3.1 feet), lower Freeport (2.3 feet), and upper Freeport (2.2 feet). In addition, this hole demonstrated the abrupt change in dip of the west limb of the DuBois Basin in the area between Sabula and Penfield. The steep dips found west of Mountain Run flatten considerably to the east.

Drill hole no. 2, which started a short distance above lower Kittanning no. 2 coal, showed that seam to be 2.8 feet thick. This hole also demonstrated the presence of the Mercer hard clay which is extensively mined for refractory products to the east.

Drill hole no. 3, which penetrated all the important coals of the area, showed only the middle Kittanning (3.2 feet) and upper Kittanning (2.8 feet) to be over 2 feet thick. The thick lower Freeport coal was also present, but has been almost entirely mined out in this part of the Basin. The Mercer hard clay was also found in this hole. At about 440 feet below the surface, drilling penetrated a major ground-water zone with sufficient hydraulic head to produce artesian flow.

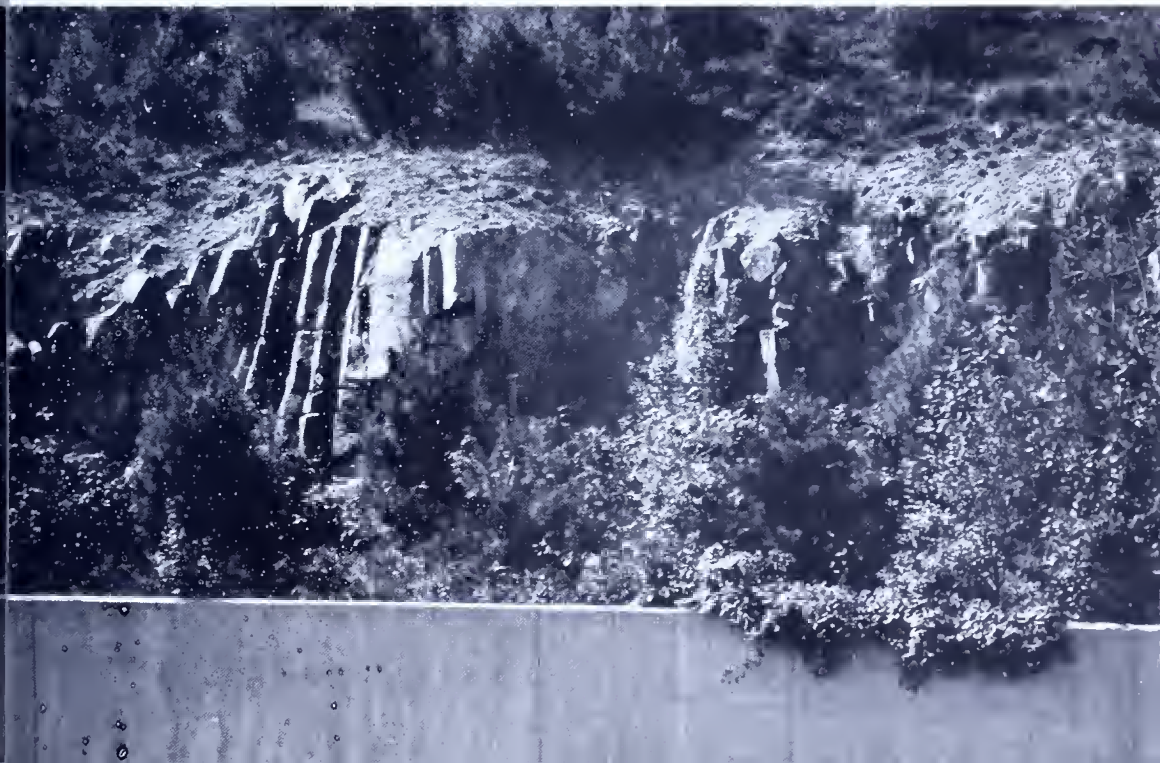
Hole no. 4 was started above the middle Kittanning coal, but no coal seams over 2 feet thick were encountered.

The Pennsylvania Geological Survey plans to examine the cores in greater detail and to conduct tests on the coals, clays, and other potentially useful units. The results of the studies will be published at a later date, but in order to provide the public with preliminary information as speedily as possible copies of the field description of the core may be obtained by writing to: Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg, Pa. 17120

COLUMNAR JOINTING IN SOUTH MOUNTAIN

Rocks that compose the core of South Mountain in Franklin County, are ancient lava flows and injections derived from volcanic areas 850 million years ago. These rocks have been metamorphosed and severely folded so that most original flow features are almost obliterated. It was thus a pleasant surprise when Dr. John Fauth of Cortland College, a cooperating geologist with the Survey, discovered well-preserved columnar joints in these volcanics. This unique columnar jointing is displayed in an abutment cut for the dam which furnishes the water supply for the Samuel Dixon State Hospital about 10 miles southeast of Chambersburg. The columns are about 20 feet high and as much as 2 feet wide, with well developed hexagonal and pentagonal sides. Even the much younger and unaltered Triassic volcanic rocks in the State do not show columnar jointing of such magnitude.

Columnar structures develop in volcanic flows or injections as the rock begins to cool. In a cooling mass, centers of contraction tend to occur at equally spaced intervals on the surface. From each center three cracks form and radiate outward at angles of 120 degrees. Intersection of these cracks produces a regular hexagonal pattern and their penetration inward makes the columns. However because of natural complexities five-sided and even four-sided columns occur. Some areas in the world, such as Giants Causeway in Ireland, are particularly well known because of this columnar structure.



FIFTY YEARS OF

September 1, 1969, marked the 50th anniversary of the Fourth Geological Survey of Pennsylvania. On this day in 1919, George Hall Ashley began his work as the Fourth State Geologist of Pennsylvania. Preceding State Geologists were H.D. Rogers from 1836 to 1858, J.P. Lesley from 1874 to 1890, and R.R. Hice from 1907 to 1914. Each of the former State Geologists headed a Survey that went out of existence after it completed the tasks established at the inception of each Survey.

Dr. George Hall Ashley

Dr. Ashley began his work September 1, 1919, even though the letter from Governor Sproul offering him the position was not written until September 4, and Ashley's acceptance of the job was not sent until September 12.

The first report of the new Survey was issued September 24, 1919, and has been followed by a steady flow of reports that deal with all aspects of the geology of Pennsylvania. Several of the early reports were concerned with the birth and rapid demise of the McKeesport gas pool, a discovery in which fortunes were made overnight. Recommendations by Ashley against over-production and drilling were ignored and many individuals lost considerable sums of money.

THE FOURTH SURVEY

Early reports (progress reports and mineral resource reports) concentrated on mineral resources but the new Survey was to concern itself with all aspects of geology and it quickly branched out to publish area geology reports. The first of these were the atlases of the New Holland and Greensburg quadrangles in 1926, and the county reports of Adams and Greene Counties in 1932. The first general geology reports appeared in 1931. A new geologic map of Pennsylvania was published in 1931 and a map of the Pennsylvania coal fields appeared in 1929. The first water resource report was issued in 1933.

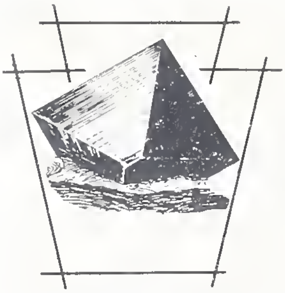
Dr. Ashley retired in 1946 and for a few months Dr. R.W. Stone filled in until Stanley Cathcart became State Geologist. Under Dr. Cathcart two new series of publications, the information circulars and the special bulletins were begun. Dr. Cathcart died in 1953 and again Dr. Stone filled in for some months until Dr. Carlyle Gray was appointed to serve. He resigned in 1961.

The present State Geologist, Dr. Arthur A. Socolow, was appointed in December, 1961. New publication series that have appeared since then are the educational series (1962) and park guides (1969). Reports continue to be published in all of the various series. During 1969, seven atlases were reprinted, and five general geology reports, eight information circulars, four mineral resource reports, two progress reports, and two water resource reports were published.

Since the Fourth Survey began 26 atlases have been published with 3 more ready for publication. Eight county reports were issued and York County is being reprinted. Eight educational series reports have been prepared as an educational tool and are distributed free. Fifty-eight general geology reports, 67 information circulars, 15 maps, 61 mineral resource reports, 178 progress reports, 11 special bulletins, 3 park guides, and 25 water resource reports have been published. There are many in preparation or in press at this time.

The staff of the Fourth Survey has grown from 1 geologist at its beginning to 25 geologists and 17 technical and clerical support personnel at the present time.

Donald M. Hoskins



EARTH SCIENCE TEACHERS' CORNER

PENNSYLVANIA ROCK AND MINERAL SETS

We deeply regret that rising costs and limited staff no longer enable us to prepare and distribute rock and mineral sets in sufficient quantities for unlimited distribution to your students. The Pennsylvania Geological Survey is now supplying only one set per teacher. It is our plan, however, to continue preparation and distribution of our geological educational booklets on a one-per-student basis. Please let us know if you would like any of these for your classroom.

ASTROGEOLOGY

Astrogeology — Geologic Research in Space is the topic of a new leaflet in the popular publication series of the U.S. Geological Survey. This timely pamphlet describes lunar geologic mapping, geologic training of the astronauts, development of geologic tools for lunar exploration, and studies of extraterrestrial materials, as well as crater investigations here on earth. Any teacher desiring one or more copies of this interesting leaflet should write directly to: U.S. Geological Survey, Distribution Section, 1200 South Eads Street, Arlington, Virginia, 20222.

JOHN WESLEY POWELL

Many of you may have noticed the new John Wesley Powell commemerative stamp that was issued recently. Official geological first-day covers with the John Wesley Powell centennial stamp issued on August 1st in Page, Arizona, are available for 50c each from the American Geological Institute, 2201 M St. NW, Washington, D.C., 20037. The envelope bears a photograph of Powell's party as it started down the Colorado a century ago.

LEHIGH RIVER GORGE STATE PARK

The geology of the proposed Lehigh River Gorge State Park in Carbon County was one of the aspects emphasized recently in a gorge tour sponsored by the Carbon and Luzerne Counties Soil and Water Conservation Districts. The September 13th trip was attended by 40 persons who were introduced to various aspects of the geology, ecology, history and park potential of the gorge by W.D. Sevon, Pennsylvania Geological Survey; Larry Sharer and Lee Skillman, Bureau of State Parks, Department of Forest and Waters; Grant L. White, Lehigh County Cultural Center; and Sam Browning, State Department of Agriculture.

The proposed state park includes about 30 miles of the Lehigh River from Francis E. Walter Dam south to Jim Thorpe. Under the proposal, the area would be conserved in its natural state with access via hiking trails and a road on a now abandoned railroad bed. Year around activity would include examination of the geology, ecology and transportation history of the gorge, boating, hunting, fishing, hiking, camping, and general sightseeing.

During the trip W.D. Sevon pointed out some of the interesting geological features in the gorge and indicated that if the park becomes a reality a guide to the geology of the gorge would be prepared for the benefit of the non-geologist who desires to learn more about geology in general and the Lehigh River gorge in particular.

William D. Sevon (front), geologist with the Pennsylvania Geological Survey, views Buttermilk Falls in the proposed Lehigh Gorge State Park area with James F. Walker, Carbon County commissioner, Larry Sharer, a planner with the Department of Forest and Waters, and Grant White (rear), director of the Lehigh Cultural Center.

SURVEY ANNOUNCEMENTS

GEOLOGIC RESEARCH IN PENNSYLVANIA

An indication of the vigorous degree of geological activity in the Commonwealth is shown by the fact that 127 separate projects are currently in progress. Geologists from the Pennsylvania Geological Survey, the United States Geological Survey, faculty and graduate students of major universities, and private concerns constitute most of the principal investigators. The degree to which the geology of the Commonwealth is deemed important is further shown by the many foreign geologists engaged in Pennsylvania projects. A breakdown of the projects by subject and the number of studies reported is as follows:

Areal geology – 24
Economic geology – 12
Engineering geology – 6
Environmental geology – 1
General geology – 5
Geochemistry – 6
Geomorphology – 3
Glacial geology – 2
Hydrology – 22
Igneous petrology – 6
Mineralogy – 3
Paleontology – 6
Sedimentary petrology – 10
Stratigraphy – 12
Structural geology – 9

Most of the results of these projects will appear in print either as publications of the Pennsylvania Geological Survey, the United States Geological Survey, or as articles in various scientific journals. From April 1968 to April 1969 a total of 51 publications concerning various aspects of Pennsylvania geology were issued. Geologic research in the Commonwealth is reported annually in a published newsletter of the Pennsylvania Geological Survey.

PITTSBURGH AREA GEOLOGY

The Pennsylvania Geological Survey in cooperation with the Pittsburgh Geological Society is preparing a new publication entitled, Geology of the Pittsburgh Area. Written by W.R. Wagner, Louis Heyman, and six others, the bulletin interprets the geology of Allegheny County, in which Pittsburgh is centrally located and examines how geology has influenced the economic development of the area and how it contributes to engineering problems in the county. The volume is dedicated to the late Charles R. Fettke, a cooperating geologist with the Survey for more than 40 years and a charter member of the Pittsburgh Geological Society.

Prepared mainly for the interested adult and the secondary school earth science teacher, the bulletin contains sections about the regional geologic setting of western Pennsylvania, rock types and their depositional environments, stratigraphy, structural geology, fossils, history of Pittsburgh's rivers, soils and landslides, and economic geology.

An important part of the bulletin is a detailed listing of 45 outstanding geologic localities that may be readily visited. The description of each locality notes the rocks exposed, geologic features which may be observed, and comments about traffic conditions, fossil collecting, and other pertinent items. This new publication will be completed and published in 1970.

RAMEY-HOUTZDALE MAPPING

Detailed geologic field mapping is underway for a comprehensive geological report on the bituminous coal fields of the Ramey and Houtzdale quadrangles which includes portions of both Clearfield and Centre Counties between Philipsburg and Glen Hope.

Gary B. Glass, coal geologist for the Pennsylvania Geological Survey, has been headquartered in Philipsburg. In the course of field work, studies will be made of all abandoned and active mining operations in that area and most exposed rocks in strip mines will be described and measured. Additionally, coal exposures will be examined in detail and measured and sampled in some cases for later analysis. Along with the collection and recording of data from mining operations, all natural outcrops, road cuts and other excavations will be examined.

A detailed geologic map of the area will be made that will show coal outcrops for all major seams as well as the folding and faulting of rocks exposed in the area. The text, which will augment the geologic map, will include coal reserve computations and maps for each of the major coal seams. An attempt will be made to include a list of all underground mining operations and their locations. The text will include sections on surface stratigraphy, structure, faulting, jointing, and mineral resources. The mineral resources section will be further subdivided into units on coal, clay, water, sand and gravel, sandstone, shale, limestone, and the engineering properties of various rock types.

Field work on this project will continue through October of this year, all of the summer of 1970 and most of the following summer. The expected completion date set for the project is mid-1972.

GASOLINE CAUSES PROBLEM

A layer of gasoline floating on the local water table is the situation which has been faced by Hampden Township just across the Susquehanna River from Harrisburg. The condition became acute this past July when a two-week period of heavy rain raised the water table so high that it intersected low points of the land surface as well as many basements. The result was the appearance of a layer of gasoline up to three feet thick floating on the water which flooded basements and lowpoints of a one square mile area.

This was an emergency situation which brought several state agencies into operation because of the fire and health hazards. A task force was formed to relieve the hazards and to prevent future reoccurrences. Since the problem concerns ground water and is controlled largely by the local geology, the State Geologist was called upon to participate in establishing the procedures for alleviating the hazard. The effected area lies entirely within a limestone area honeycombed with solution cavities and sink holes. Geologic examination resulted in definitions of local fracture traces which might be the major zones along which the gasoline could accumulate or migrate. Drilling and pumping has been concentrated along these subsurface channelways.

The source of the gasoline which entered the ground has not yet been established, but investigations center around three adjacent tank farms and two pipelines. The companies are all cooperating to resolve the problem and have jointly carried out a drilling and pumping program to remove the gasoline. By the middle of October, 35 shallow wells had been drilled in the area and more than 112,000 gallons of gasoline had been pumped out of the ground.

The weather has helped to alleviate the hazard. Very little rainfall since the end of July has permitted the water table to drop many feet so that the gasoline no longer appears exposed in the lowlands and basements. Pumping will continue until the gasoline is completely removed from the subsurface.

The Pennsylvania Geological Survey is pleased that its geologic mapping of the area, as well as its accumulated understanding of ground-water behavior, have contributed to the alleviation of this problem.

THERE ARE LIMITS

The Pennsylvania Geological Survey apologizes to the little girl who wrote and asked to "Please send me all the rocks of Pennsylvania". Our limited shipping budget did not permit us to ship the gillions of tons involved in "all the rocks of Pennsylvania". We hope she enjoyed the several specimens we did send.

NEW SURVEY PUBLICATIONS

The following list of publications has been released by the Survey during the past few months. All of these publications are available at the Capitol Book Store, 10th and Market Streets, Harrisburg, Pennsylvania, 17125. Checks should be made payable to the Commonwealth of Pennsylvania. For Pennsylvania addresses, please add 6% State Sales Tax.

Publication			*Price*
A	27	(Reprint) **Geology and Mineral Resources of the Pittsburgh Quadrangle,** by M.E. Johnson (236 p., 28 fig., 32 pl.).	$8.75
A	55	(Reprint) **Geology and Mineral Resources of the Smicksburg Quadrangle,** by M.N. Shaffner (252 p., 103 fig., 11 pl.).	8.75
G	33	**Mineral Collecting in Pennsylvania,** 3rd Edition, by D.M. Lapham and A.R. Geyer.	.50
G	53	**A Lithostratigraphic, Petrographic and Chemical Investigation of the Lower Middle Ordovician Rocks in Central Pennsylvania,** by M. Rones, (224 p., 26 fig., 8 pl.).	3.00
G	57	**Surficial Geology of the Stroudsburg Quadrangle, Pennsylvania-New Jersey,** by J.B. Epstein (67 p., 19 fig., 3 pl.).	2.75
IC	64	**The W.L. Newman Phosphate Mine, Juniata County, Pennsylvania,** by W.D. Carter (16p., 3 fig.) .	.35
IC	65	**Peat Bog Investigations in Northeastern Pennsylvania,** by C.D. Edgerton (53 p., 30 fig.).	.85
IC	66	**Geology of Flagstone in the Endless Mountains Region, Northern Pennsylvania,** by J.D. Glaeser (14 p., 8 fig.).	.25
PR	177	**Oil and Gas Developments in Pennsylvania in 1968,** by Dana R. Kelley and others (48 p., 13 fig., 12 tables).	.65
PR	178	**Representative Gamma-Ray Logs from Shallow and Deep Wells, Western Pa.** by Walter R. Wagner (2 plates).	.85

GEOLOGISTS OF AMERICA TO CONVERGE ON NORTHEASTERN PENNSYLVANIA

In conjunction with the 82nd Annual Meeting of the Geological Society o America in Atlantic City, New Jersey, in November of this year, visiting geol gists from throughout the United States will be shown some of the geology o northeastern Pennsylvania during a three day pre-convention field trip. Approx mately 100 geologists are expected to attend the trip.

The first two days of the trip will demonstrate the interrelationship of th stratigraphy, sedimentation, structure, geomorphology, glacial geology, ar economic geology of the Middle Ordovician through part of the Middle D vonian strata and overlying surficial deposits in the area between the Delawa and Lehigh Rivers in eastern Pennsylvania. The trip leaders for this section of th trip will be Jack and Anita Epstein of the United States Geological Survey.

The last day of the trip will be led by W.D. Sevon, a geologist with th Pennsylvania Geological Survey. The participants will be introduced to the rocl and geologic history of the Pocono Formation at Jim Thorpe and in the Lehig River Gorge south of Rockport. The trip will continue northward in the gorg and view extensive rocks of the Mauch Chunk Formation near Rockport. Th final stop of the trip will be at the Hickory Run Boulder Field at Hickory Ru State Park.

CALENDAR OF EVENTS

November 10-12 —	1969 Annual Meetings of the Geological Society of America and Associated Societies. Headquarters hotel is Chalfonte-Haddon Hall, Atlantic City, New Jersey.
November 14 —	University of Pennsylvania Geology Seminar. Dr. Peter J. Wyllie, Univ. of Chicago, "Ultramafic Rocks and the Upper Mantle."
November 18 —	University of Pennsylvania Geology Seminar. Dr. Brian Mason, U.S. National Museum, "Extraterrestrial Mineralogy."
November 25 —	The Pennsylvania State University Geology Seminar. Dr. Robert A. Phinney, Princeton Univ., "Seismological Study of the Core."
November 25 —	University of Pennsylvania Geology Seminar. Dr. Raymond C. Fletcher, The City College, City University of New York," The Effect of Non-hydrostatic Stress on Metamorphic Reactions."

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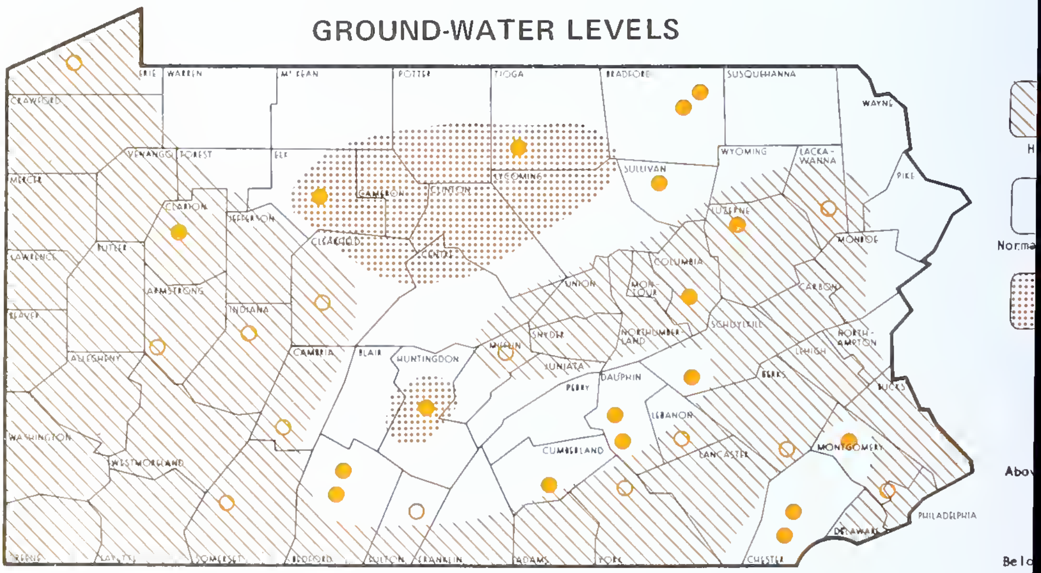
SEPTEMBER
GROUND-WATER LEVELS



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PENNSYLVANIA GEOLOGY

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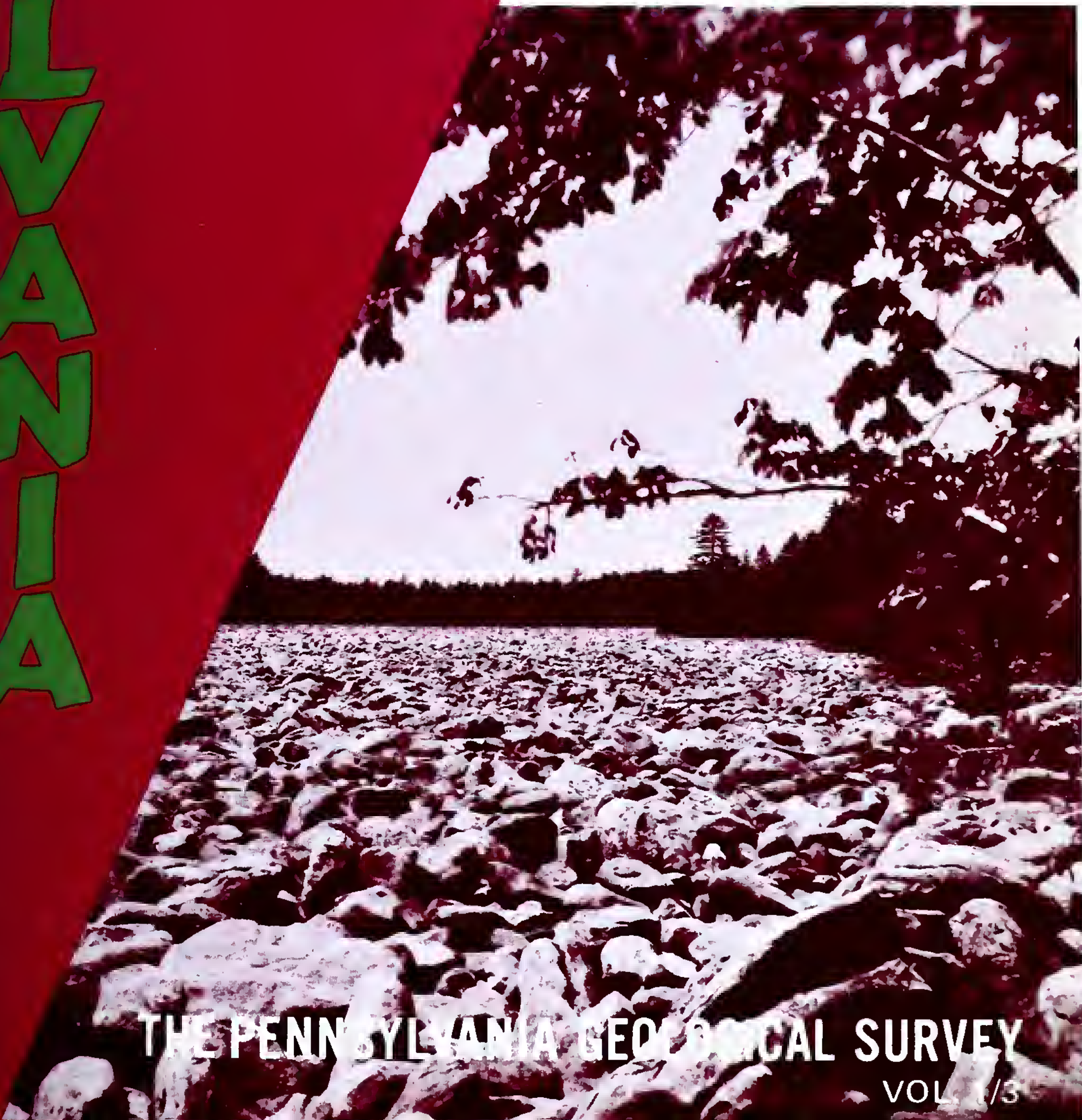


THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 1/3

COMMONWEALTH OF PENNSYLVANIA
Raymond P. Shafer, Governor

STATE PLANNING BOARD
Irving Hand, Executive Director

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

CONTENTS

The State Geologist Reports 1
Annual Oil and Gas Report Now Available 2
Russians Plan for Geologists 2
Medicine and Industry Look at Pennsylvania Brines 3
Northeast Geologists to Meet in Pittsburgh 4
Geology Computer Course 5
North American Paleontological Convention 5
Natural Gas Price Increase 6
Mineral Collecting in Pennsylvania 7
Survey Participates in GSA Meeting 8
Earth Science Teacher's Corner 9
Quartz Crystals Found in Lehigh Gorge 11
Phosphate in Juniata County, Pennsylvania 13
Survey Announcements 14
New Survey Publications 16
Calendar of Events 16

on the cover – Boulder field at Hickory Run State Park, in northern Carbon County. Th unique geologic feature, a product of the ice age, was recently dedicated as an offic National Natural Landmark.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topo graphic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania 17120.

DECEMBER 1969

FROM THE DESK OF THE STATE GEOLOGIST . . .

The United States has during the past 30 years used more minerals and fuels than did the entire world in all previous history. During the next 20 years, it is estimated our country will double its present rate of mineral and fuel consumption.

We are living in a mineral-based society in which our tools, appliances, housing, transportation, fuels, and even fabrics are all derived from mineral matter. In the face of this growing mineral consumption and dependence, new mineral deposits become more difficult to find as the more easily found deposits have already been discovered and are being used up; and you just can't grow another crop of minerals as you can with agricultural needs.

How does all this relate to Pennsylvania? We are a leading mineral-producing state, being the sixth largest mineral producer in the country. As a major industrial state with one of the largest populations, we are also a leading consumer of mineral resources. Thus, we are faced with the challenge of maintaining our high level of mineral production so that we can accommodate our own high level of mineral consumption.

But, we are also a Commonwealth that is awakening to the need to protect the magnificent landscape with which we have been endowed, and to preserve and improve the quality of our waters which the citizens must have.

Thus, Pennsylvania faces a real challenge: to continue to produce minerals to serve our requirements, while also conserving our landscape and our waters. The two are reconcilable, but only by serious and sincere efforts by all concerned. It will require new planning, new research, new procedures, and interdisciplinary thinking. Geologists in education, industry, and government can and must have a role in this effort. The Pennsylvania Geological Survey pledges to do its part.

Arthur A. Socolow

ANNUAL OIL AND GAS REPORT NOW AVAILABLE

The yearly report of developments of the Pennsylvania oil and gas industry and related subsurface drilling during 1968 has been published and is now available for distribution as Progress Report 177. The report is divided into two major parts. In the first part, important developments ranging from significant well completions to exploratory interest and related Survey studies are highlighted. The second part is devoted to oil and gas industry statistics for the year. This section has been made consistent with national industry statistical reporting for Pennsylvania. A statement has been included summarizing the status of the local industry on the basis of the yearly figures, and the statistics have been clearly related to categories of drilling and completion, as well as production and reserves. Many comprehensive tables have been included. To increase the usage of this annual summary, brief sections on gas storage and subsurface disposal for other industry have been included. Progress Report 177 may be purchased for $0.65 plus tax from the Pennsylvania Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125.

To accompany the major features included in the yearly progress report on the oil and gas industry, the first step has been made to standardize subsurface terminology and more clearly describe the stratigraphic position of major producing and other horizons of interest. A separate publication, Progress Report 178 includes selected type gamma-ray log sections. The deep horizon type log includes generalized lithology and in addition to subsurface stratigraphic nomenclature and notes, shows the location of producing intervals at a scale of 1 inch equals 200 feet. The shallow horizon type logs have representative curves for three different areas at the scale of 1 inch equals 100 feet. Major producing intervals are shown and the reservoir sandstones within these intervals are listed. Progress Report 178 is available for $0.85 plus tax from the Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125.

RUSSIANS PLAN FOR GEOLOGISTS

Taken from August 14, 1969 issue of Wall Street Journal.

By Felix Kessler

Staff Reporter of The Wall Street Journal

MOSCOW — The request sounds trivial enough, but it came from a government ministry — and the architects had to regard it as important.

> *"They wanted a housing development for geologists," says Nathan Osterman, Moscow's leading experimental designer. "Now, geologists spend a lot of time being cold and uncomfortable in the field. The point was to make them happy at home — but not so comfortable that they wouldn't want to go out into the field again."*

Medicine and Industry Look at Pennsylvania's Brines

In certain areas of western Pennsylvania formations below the surface are porous and contain large amounts of highly concentrated salt water. These occurrences represent sea water trapped and buried with sediments on the floor of ancient seas which covered portions of Pennsylvania many millions of years ago. Processes accompanying the transformation of the sediments into rocks, and later periods of upheaval of the land, concentrated the entrapped sea water salts to the point that the original water is now essentially a bittern containing up to 30 percent or more by weight of various kinds of salt.

Successful experience in commercial brine salt production in surrounding states is beginning to lead some chemical companies to seriously consider the potential of a similar industry being developed in Pennsylvania, not only for obtaining the common table salt, sodium chloride, but for other associated and rarer salts and elements and for the manufacture of chlorine. As a result, the distribution and composition of Pennsylvania salt deposits and brines are receiving increasing attention.

Strangely enough advances in medicine are also adding to interest in Pennsylvania's subsurface salt-water occurrences. Medical research and clinical tests have indicated that the element lithium may be important in the treatment of manic-depressive disorders. Rare natural occurrences of waters having high concentrations of this element are therefore becoming of considerable interest. It is possible that use of such natural waters may locally contribute to a decreased frequency of these disorders, and conversely a local deficiency of this element in drinking water may contribute to an increased frequency of these disorders. In addition, natural occurrences of waters with a high lithium content are of interest because these waters could potentially be used for relatively inexpensive treatment under medical supervision of dosages which are critical. The brine produced by an old well in northwestern Pennsylvania, formerly used as a spa, had been reported to contain an unusually high concentration of lithium, the content being within therapeutic ranges. Preliminary investigations have revealed other formation waters in western Pennsylvania may also be unusually endowed with lithium. As a result, the subsurface brines of Pennsylvania are becoming of considerable interest to medical researchers.

With consideration being given to obtaining salt from highly concentrated brines, and medical interest in some of these formation waters, it is possible that Pennsylvania's underground salt water may well become a resource of economic significance in the future.

NORTHEAST GEOLOGISTS TO MEET IN PITTSBURGH

The fifth annual meeting of the Northeastern Section of the Geological Society of America (GSA) will be held February 12-14, 1970 at the Hilton Hotel, Pittsburgh. Two major symposia, one on Oceanography and the other on the Presentation of Geological Data for Environmental Planning, will highlight the comprehensive, three-day geological program. Speakers will include many of today's outstanding researchers in geology and related sciences.

The program will include sessions on Structural Geology, Sedimentology and Paleontology, Stratigraphy, Geomorphology, Mineralogy and Geochemistry, Engineering Geology, and General Geology. A technical and educational geologic exhibit area will demonstrate new research and new products in the field of geology. Other activities include an open house at Carnegie Museum on the evening of February 13 and a special sight-seeing tour for the ladies.

The meeting is sponsored by the Pittsburgh Geological Society in cooperation with the Carnegie Institute Museum, Pennsylvania Geological Survey, University of Pittsburgh, United States Bureau of Mines, The Pennsylvania State University, and Duquesne University. An attendance of over 600 geologists from the eastern half of the country is expected. The general public is welcome to attend.

Geology Computer Course

A one-day course for college teachers of geology will be given on Wednesday, February 11, 1970 preceding the opening of the Northeastern Section Meeting of the Geological Society of America in Pittsburgh. The course, entitled "Using Digital Computers to Process and Display Geologic Data," will be given by Gulf Research and Development Company in cooperation with the American Geological Institute's Council on Education in the Geological Sciences.

Enrollment is limited to 80 persons on a first-come-first-served basis with a registration cost of $5.00 to be donated to the Northeastern Section of the GSA. Reservations may be made by writing to: Dr. H.A. Boyd, Gulf Research and Development Company, P.O. Drawer 2038, Pittsburgh, Pa. 15230.

North American Paleontological Convention-1969

In September 1969, the first North American Paleontological Convention was held at the Field Museum of Natural History in Chicago. The Pennsylvania Geological Survey was represented by Thomas M. Berg, staff coal geologist, who is currently devoting some time to Carboniferous invertebrates in Pennsylvania. Over 400 paleontologists attended the meetings, probably the largest single gathering of paleontologists in history.

Fourteen symposia were held, covering a broad spectrum of topics including correlation techniques, extraordinary fossils, paleoclimatology, genus concepts, phosphatic fossils, reefs, computer applications, and community evolution. It was impressive to see that paleontology is moving ahead rapidly as new tools are introduced. Computers are being used to simulate and check stratigraphic and geographic ranges of fossil groups as well as on morphology and taxonomy of fossils. The scanning electron microscope is being used for studies beyond the range of conventional microscopes. Laser microemission spectroscopic analysis is revealing secrets within the smallest fossils.

A highlight of the convention was the announcement of the finding of a conodont animal. Conodonts are phosphatic, tooth-like microfossils that have been described and studied by paleontologists for almost one hundred years. For that length of time, however, no one has ever seen a trace of the animal that bore the structures. Several specimens of the curious, 2-inch long creature were displayed; its exact classification will have to await further research.

NATURAL GAS PRICE INCREASE IMPORTANT TO PENNSYLVANIA PRODUCTS

Pennsylvania Gas Company of Warren, Pennsylvania has announced an increase of 10 cents per thousand cubic feet, from 28 to 38 cents, in the field price it will pay for gas from new wells in Erie County, Pennsylvania. The new price, effective November 1, 1969 and to remain in effect until further notice, will be for intrastate gas ready for market and delivered to certain pipelines in the firm's system in Erie County.

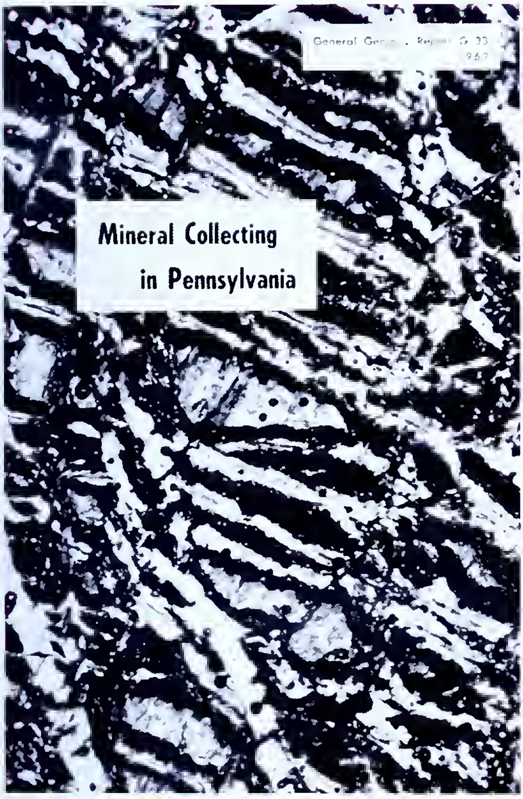
The Federal Power Commission has proposed setting ceiling rates for interstate gas produced in the Appalachian and Illinois Basin areas through the rule-making approach to avoid the need for full-blown evidentiary hearings. The commission proposes ceiling rates ranging from 28 to 32 cents per thousand cubic feet in the Appalachian Basin and 21 cents in the Illinois Basin.

The increases in the purchase price of gas are due to the beginnings of a possible major shortage of natural gas. The Consolidated Natural Gas System Companies, a large distributing company which serves Pennsylvania, told the FPC early this year:

> *"Consolidated Companies secure the bulk of their necessary supplies by purchase from five of the major interstate pipeline companies: Panhandle Eastern Pipe Line Company, Tennessee Gas Pipeline Company, Texas Eastern Transmission Corporation, Texas Gas Transmission Corporation, and Transcontinental Gas Pipe Line Corporation. Historically, Consolidated Companies have had no problem in contracting for increase in supply, and, indeed, these companies have normally vied for an opportunity to increase their service to us. While we hope the situation may change, none of the pipeline suppliers are now able to contract for the quantities we require—it is not in the public interest to reach a point—as we have in 1968—where distribution and pipeline companies are unable to contract for gas to meet increasing consumer demands."*

A simple way to produce a surplus of any product is to have the government fix and enforce a legal minimum price above the price that might otherwise prevail. The above price increase is a step in the right direction.

MINERAL COLLECTING IN PENNSYLVANIA



A new, revised third edition of *Mineral Collecting in Pennsylvania,* Bulletin G 33 of the Topographic and Geologic Survey has been published and released. Sixty-one mineral collecting localities in 23 counties are described including seven new localities. These seven include two in Lycoming County and one each in Adams, Clinton, Delaware, Lancaster, and Schuylkill Counties. Many new minerals and mineral descriptions have been added to previously described localities so that each is more complete than before.

The new, expanded 164-page edition features a full-colored cover of serpentinite rock as seen through a microscope and is 16 pages longer than the previous 1965 edition.

Since 1959, the Survey's *Mineral Collecting in Pennsylvania,* by D.M. Lapham and A.R. Geyer, has been a best-seller. There are thousands of mineral collecting enthusiasts in Pennsylvania and adjacent states; in fact, mineral collecting has become a major hobby throughout the United States. This new third edition meets the needs of these hobbyists with up-to-date information on the best collecting localities in Pennsylvania.

The Pennsylvania Geological Survey wishes to thank all the mineral collectors and professional geologists who have sent in minerals and mineral data over the past four years; the material they have supplied has added significantly to the present edition. The Survey will welcome further information, too, so that it can begin assembling data for a future edition. As the hobby grows, so does the need for interesting and helpful information.

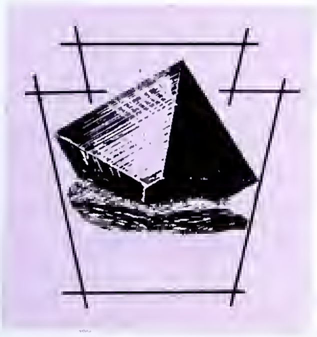
Mineral Collecting in Pennsylvania, Bulletin G 33, third edition, is available from the Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125, for $0.50 plus 6 percent sales tax.

SURVEY PARTICIPATES IN OUTSTANDING GSA MEETING

About 3,400 scientists from various geologic fields throughout the world met in Atlantic City from November 8-12 to attend the technical meetings and exhibits of The Geological Society of America. The highlight of the meeting was the presentation of an honorary fellowship in the society to Astronaut Neil Armstrong who was cited as having taken the longest geologic field trip in history – to the moon! Armstrong said that when he first looked out of the LEM he felt like a freshman geologist watching "a Caterpiller tractor making a fresh road cut". A measure of the importance of multi-disciplinary effort in the sciences is that this year Dr. Harold C. Urey, a Nobel prize winner in chemistry, and Dr. Francis Birch, a physicist, received the highest medals awarded by the society for the advancement of geologic science.

The geologic exhibits were another high point of the meetings. Particularly interesting was a specimen of moon rock on display. This heavily guarded fragment received much scrutiny through a massive glass case. The exhibit of the Pennsylvania Geological Survey showing various projects in progress, recent publications, and utilization of the geologic information also drew the attention of large numbers of scientists.

Survey personnel participated in the technical session and were field trip leaders in the geologic excursions that preceded the meetings.



EARTH SCIENCE TEACHERS' CORNER

NEW GEOLOGIC GUIDEBOOK AVAILABLE

An excellent guidebook was written for the 34th annual Field Conference of Pennsylvania Geologists held this year on October 3rd and 4th in Hazleton, Pennsylvania. The guidebook's title, *The Pocono Formation in Northeastern Pennsylvania,* explains its contents. The field trip described in the book permits you to examine the important aspects of the Pocono Formation in this area. It will give you a distinct impression of each lithologic component in the formation, the origin of some of the components, and the regional variations within the formation. This guidebook is available for $2.00 from the Field Conference of Pennsylvania Geologists, c/o Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg, Pa. 17120.

U.S. GEOLOGICAL SURVEY'S LEAFLET SERIES

Several new U.S. Geological Survey leaflets have been added to their series of popular geology pamphlets. *Use and Conservation of Minerals* is six pages in length and describes the Survey's point-of-view on mineral conservation. *Geological Survey Photographic Library* tells how to obtain prints and negatives from the 140,000 photograph collection maintained by the U.S.G.S. *Elevations and Distances in the United States,* includes extreme and mean elevations for every state, plus geographic centers for each state, and similar interesting data. These leaflets are free; write to Information Office, U.S. Geological Survey, Washington, D.C. 20242.

SCIENTIFIC AMERICAN –SEPTEMBER 1969

For those of you teaching Oceanography in your earth science course, the September issue of Scientific American is a must for your library. This entire issue is devoted to selected articles on oceanography by noted people in this field. The following titles are some of those included: *Man and the Sea, The History of the Sea, The Circulation of the Seas, The Continental Shelves, The Deep-Sea Floor, The Ecology of the Sea, Food from the Sea,* and *The Physical Resources of the Sea.* Single copies are available from Scientific American, 415 Madison Ave., New York, N.Y. 10017, and should be available as offprints in the near future.

TECTONIC MAP OF NORTH AMERICA

The *Tectonic Map of North America* has just been published in two sheets by the U.S. Geological Survey. The map may be purchased separately or with a discussion (Professional Paper 628). The mounted map measures 64 inches wide and 76 inches long (N-S direction). An extensive legend of over 100 colors, patterns, symbols, and characters explaining the map is located along the left-hand side.

The map (scale 1:5 million) which sells for $5.00 and the discussion (Professional Paper 628, 95 p.) for $1.00 can be ordered directly from the U.S. Geological Survey, Washington, D.C., 20242.

RARE METALS PRODUCED IN PENNSYLVANIA

Several very rare metals are mined in Pennsylvania. Cadmium is produced as a by-product of zinc mining along with sphalerite, the prime ore mineral for zinc at the Friedensville, Pennsylvania Mine of the New Jersey Zinc Company near Allentown. Cadmium occurs there as the mineral greenockite and is processed at Palmerton, Pa.

Cobalt occurs in pyrite ("fool's gold") at Bethlehem Corporation's magnetite iron mines at Cornwall and Morgantown, Pa. The cobalt is not visible and does not occur as a separate mineral. It is recovered during the refining process which is used to extract copper, another by-product which occurs with the iron ore.

The same mines that produce the cobalt and iron also yield gold and silver, although in small amounts. Like the cobalt, gold and silver do not occur as visible minerals but are found in the copper-ore mineral, chalcopyrite.

QUARTZ CRYSTALS FOUND IN THE LEHIGH GORGE

Some of the finest specimens of quartz crystals ever found in Pennsylvania have been recovered recently from a site along the Lehigh River near White Haven. This location is within the upper reaches of the Lehigh River Gorge, one of the most picturesque spots in Pennsylvania. The quartz crystals found here are like the scenery, clear and beautiful, each complimenting the other. Many museum specimens have been uncovered and are on display at the Lehigh County Cultural Center in Allentown, the William Penn Memorial Museum in Harrisburg, and the West Chester State College Museum in West Chester.

Some of the more interesting characteristics of these quartz crystals (see photograph) are:

Color:

Colorless, transparent to milky white; base of clear crystals is frequently milky.

Size:

Length to 8", width to 2"; elongation is usually 1:1.5 to 1:5, 1:2 is most common.

Inclusions:

Sometimes *iron and manganese oxides,* especially along the twin plane of a penetration twin or overgrowth crystal.

Habit:

Simple crystal faces; the only ones observed were the prism, positive rhombohedron, and the negative rhombohedron. Commonly the positive rhombohedron is better developed than the negative, and occasionally almost to the exclusion of the negative.

Twinning:

Dauphine Law — parallel to the "c" axis is the most common.

Japan Law — twinned on the rhombohedral face moderately common.

Zwickau Law — prism faces twinned at a 42 degree angle; moderately common.

Special Features:

1. All rhombohedral faces are lightly etched.
2. Rhombohedral faces rarely show skeletal development (indented, hopper-shaped faces).
3. Striae on prism faces are often discontinuous as a result of twinning and disturbed crystal growth.

The thick beds of sandstone exposed along the Lehigh River in this area are part of the Pocono Formation (see photograph of site). A greenish-gray sandstone is present at this quartz crystal locality. Generally speaking, these beds of sandstone strike north-south and dip approximately 30 degrees west. The crystals are found attached to bedding and joint surfaces as well as loose crystals surrounded by glacial debris within the open joints. The opening of these joints several feet below the surface has resulted in large cavities filled with protruding quartz crystals — truly an awe-inspiring sight. The dense concentration of loose crystals in these open joints may be the result of thousands of years of weathering action on the overlying sandstone beds which today have been completely eroded away. Most of the joint planes observed, trend east-west and are vertical.

This quartz crystal locality lies within the proposed Lehigh Gorge State Park. Hopefully, the site will be designated as an active mineral collecting locality.

Alan R. Geyer
Davis M. Lapham

PHOSPHATE IN JUNIATA COUNTY, PENNSYLVANIA

Small deposits of the mineral phosphate are scattered throughout central and eastern Pennsylvania. Although none are currently being mined, phosphate is an important mineral source of phosphorous and fertilizer and all occurrences are worthy of investigation for their future potential.

One such deposit, the W.L. Newman Mine, was operated during the end of the last century. It has recently been re-evaluated by W.D. Carter in Pennsylvania Geological Survey Information Circular 64, 1969, entitled *The W.L. Newman Phosphate Mine, Juniata County, Pennsylvania*. The phosphate occurs in the minerals apatite, wavellite, and crandallite (a new mineral for Pennsylvania) either in a bedded, nodular zone or in veinlets. The phosphate grade ranges from a trace to 26 percent. The geology of the area, a description of the old mine workings, and new chemical analyses are included in the report.

Information Circular 64 is available for $0.35, plus state sales tax, from the Pennsylvania Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125. (Make check payable to "Commonwealth of Pennsylvania".)

SURVEY ANNOUNCEMENTS

UPDATING CRUDE OIL RESERVE ESTIMATES OF PENNA.

Since the 1950 publication of Bulletin M 32 *Crude Oil Reserves of Pennsylvania* additional data has become available which can be used in updating the crude oil reserves of the Commonwealth. William S. Lytle, Senior Research Geologist of the Oil and Gas Division, has initiated a program to revise and update the oil reserve estimates for Pennsylvania. After updating the reserves, new data will be used annually to refine reserve estimates and keep them current.

During the last twenty years, the petroleum engineer has learned how to better interpret the results obtained from: 1) the analysis of cores taken from the producing reservoir rocks of the oil fields, 2) the secondary and tertiary recovery methods of extracting the oil from the reservoir rocks, and 3) new engineering recovery methods and geophysical logging instruments.

The reserve estimates will be made on a field-by-field basis using volumetric, decline curve, material balance and other methods. The engineer's knowledge of reservoir and production engineering will be integrated with the available data, especially when the data is incomplete, to arrive at a crude oil reserve figure.

The crude oil reserve figures will be particularly useful to: 1) the petroleum industry to evaluate oil-producing areas in the Commonwealth; 2) the petroleum operator who is new in the area and wishes to operate in Pennsylvania; and 3) government agencies who need to know the crude reserves for each state for future planning.

This project is already under way. Petroleum operators are being contacted for data to be used in the report. The more data made available to the Pennsylvania Geological Survey, the more comprehensive and detailed the report will be. The cooperation of all pertinent parties will be greatly appreciated.

OUR MOON IS OLD, OLD, OLD

Isotopic chemical analysis of lunar rocks brought back by Apollo 11 astronauts from the Sea of Tranquility indicates that they are approximately 3.5 billion years old. The earth is thought to be 4.6 billion years old but no one has ever found earth rock older than 3.3 billion years because the accessible crust is too altered. The lunar age determination lends support to the theory that the moon and earth were created as twin planets. The age determinations could make the moon a unique place to study the origin of the solar system as well as lunar history.

TULLY LIMESTONE STUDY PUBLISHED

The Pennsylvania Geological Survey has released a new publication, Information Circular 60, entitled *Devonian Tully Limestone in Pennsylvania,* by Philip H. Heckel. The report describes the nature of the rock sequence making up the formation in Pennsylvania, and compares it to the sequence in New York State where the unit was originally named. Included in the report are descriptions of the physical characteristics of the rocks, identification of the fossils found in them, and the general chemical composition of the various rock layers comprising the Tully Formation.

Tully rocks in Pennsylvania contain much more shale than those in New York, and the New York exposures are composed predominantly of limestone. From this the author concludes that the source of the shale lay to the east and that the limestone material was derived from the north. These sediments were deposited in the shallow sea that covered this area more than 300 million years ago.

This report should be useful to paleontologists, geologists, and to industry. For paleontologists the fossil assemblages in these rocks permit regional comparison and aid in regional correlation. Geologists will be interested in the regional changes of these rocks as an aid in determining their geologic history. Industries that utilize stone will find use in the physical characteristics such thickness variations, proportion of shale to limestone, as well as the gross chemical composition of this rock sequence; such data are useful in determining whether the rocks included in the Tully Formation may be useful as raw material for industrial purposes.

Information Circular 60 is available for $0.50 plus sales tax from the Pennsylvania Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125.

NEW REPORT ON CLAYS AND SHALES OF GREENE COUNTY

The Pennsylvania Geological Survey has published a new report entitled, *Analysis and Potential Uses of Selected Shales and Clays, Greene County, Pennsylvania.* This report, Information Circular 67, is by John Roen and John Hosterman.

Mineralogical, chemical, and physical test data are given for samples collected in the field. The results of the tests show that some of the samples may be used for the manufacture of common face brick, decorative brick, and expanded lightweight aggregate. This publication should help to stimulate new industrial and mining development and contribute to the future economic growth of the Commonwealth.

Information Circular 67 is available for $0.35, plus 6 percent state sales tax from the Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125.

NEW SURVEY PUBLICATIONS

The following list of publications has been released by the Survey during the past few months. All of these publications are available at the Division of Documents, 10th and Market Streets, Harrisburg, Pennsylvania, 17125. Checks should be made payable to the Commonwealth of Pennsylvania. For Pennsylvania addresses, please add 6 percent state sales tax.

Publication			*Price*
G	55	**Glacial Geology of Northwestern Pennsylvania,** by G. White and others (88 p., 43 fig.)	$1.00
G	58	**Petrography and Stratigraphy of Carbonate Rocks of the Lower and Middle Ordovician,** by H. Chafetz (39 p., 3 fig., 2 pl.)	0.85
IC	67	**Analysis and Potential Uses of Selected Shales and Clays of Greene County, Pennsylvania,** by J. Roen and J. Hosterman (29 p., 2 fig., 1 pl.)	0.35
M	61	**A Resume' of Some Major Geophysical Logging Methods for Pennsylvania Operators,** by Dana Kelley (81 p., 41 fig.)	1.30

CALENDAR OF EVENTS

January 9	Harrisburg Area Geological Society D.S. Ritter: Geomorphology at Pyramid Lake, Nevada William Penn Memorial Museum, 8. p.m.
February 12-14	Geological Society of America, Northeast Section Annual Meetings, Pittsburgh Hilton Hotel.

HAPPY NEW YEAR

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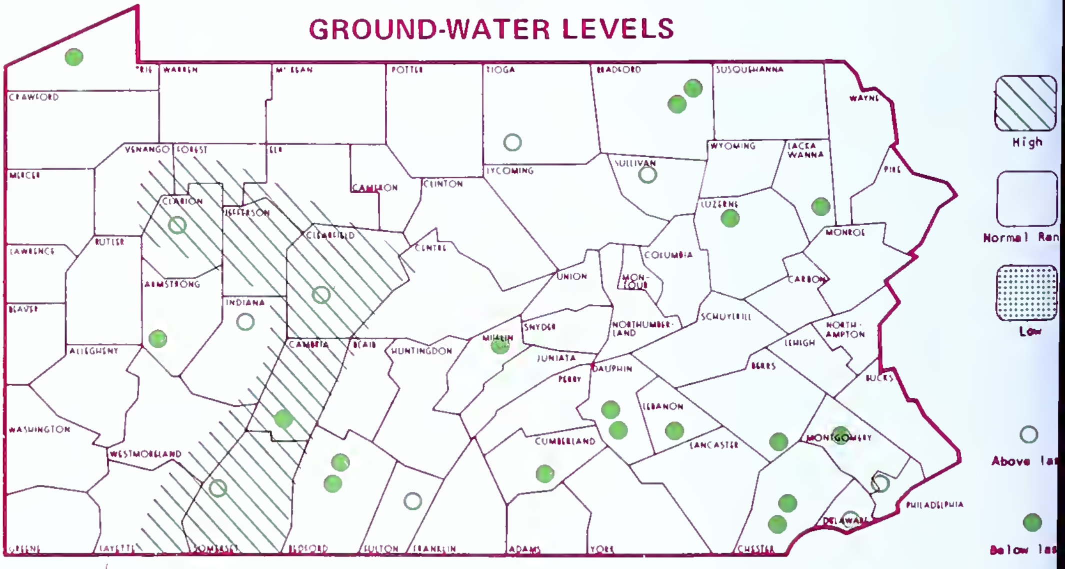

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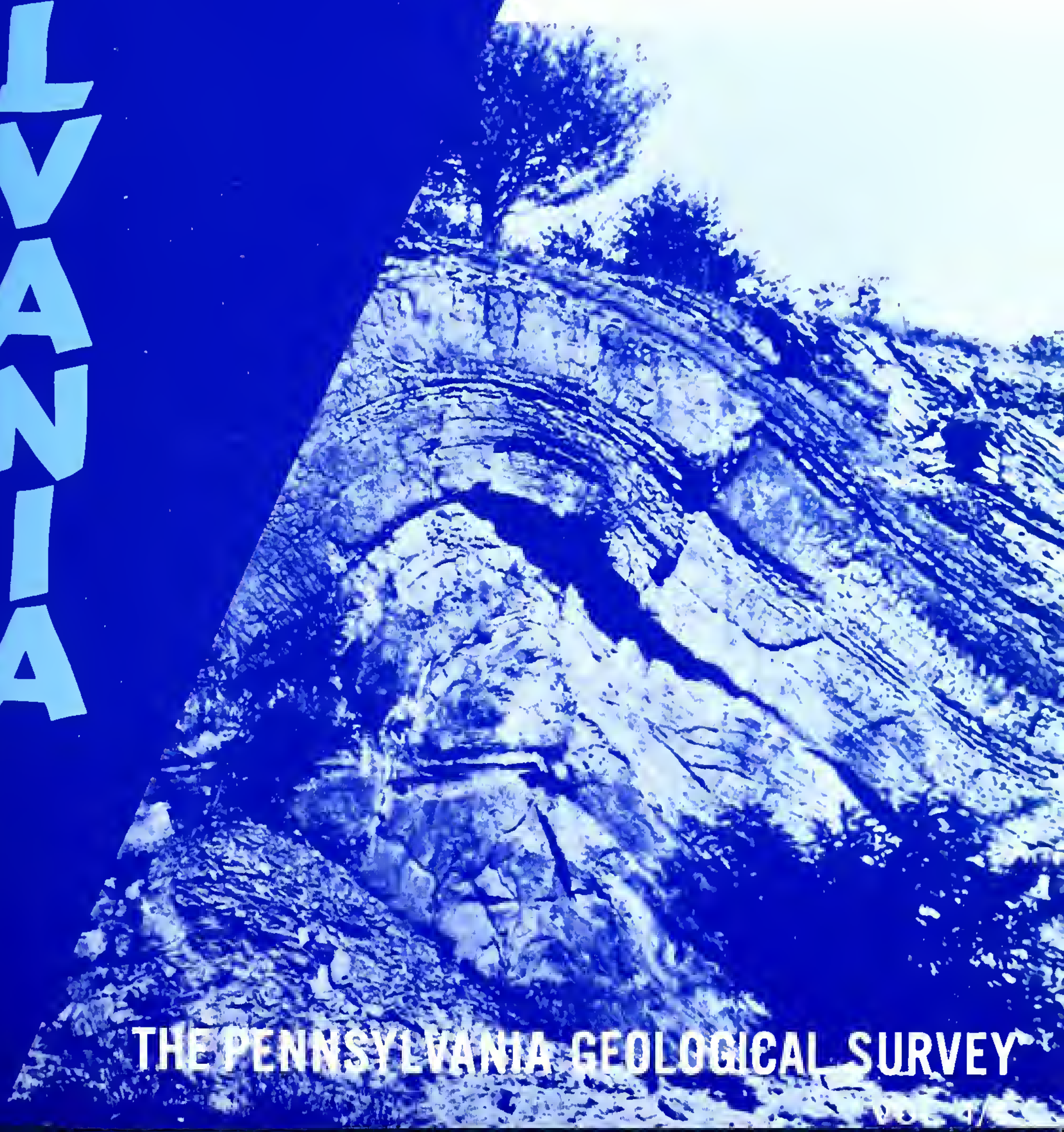

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CONTENTS

The State Geologist Reports 1
New Oil and Gas Base Maps Available 2
New Environmental Course 3
Salty New Salt Report 4
Future Deep Drilling in Pennsylvania 5
Survey Reports Answer Many Questions 6
Rain Water Not So Pure 7
Measuring Landscape Appeal 7
Water Use in the Nation 8
Earth Science Teacher's Corner 10
Fossils Galore 12
Survey Announcements 13
Calendar of Events 15
Mineral-Collecting Clubs in Pennsylvania 16

ON THE COVER – Folds in Helderberg limestone , north of Blain, Perry Count

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

FEBRUARY 1970

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

GEOLOGY – A PLANNING TOOL

The effect of geology on man's activities and the relationships of geology to land use has a long and fascinating history. It has its beginnings with stone age man and man the cliff dweller. Today, we see it in such forms as the search for uranium to fuel our atomic era, the geo-political implication of Middle East oil, and the awakening interest in conservation of such geologic features as the Everglades and the Grand Canyon.

Along the road of history, geology has stimulated trade routes and colonialism (for better or worse) as nations needed more mineral resources. Geology has controlled the locations of seaports and the paths of continental transportation by way of rivers and valleys through the mountains. Along the way, it was recognized that the quality of soils was a function of the underlying rocks, as is the quality and quantity of water.

The Pennsylvania Geological Survey has released a new map which further highlights the effect of geology upon our environment. The limestone map announced in this issue delineates a significant portion of Pennsylvania's land area which is underlain by rocks of mixed blessings. These limestone-dolomite rock areas are commonly hazards and trouble spots for construction due to caves and sinkholes; planners and engineers are well advised to plan accordingly. Yet these same limestone-dolomite areas may have rich soil ideal for farming, may yield large amounts of good water for consumption, and may serve as excellent raw material sources for lime, cement, or crushed stone.

The Pennsylvania Geological Survey is actively concerned with the effect of geology on man's activities, whether it be geologic features as hazards or as resources. We recognize that it is not enough to map and name the rocks and minerals of Pennsylvania – we must go one step further and define their impact on man's land use and environment. Geology is thus a valuable tool for planning, for conservation, and for efficient expansion of man's many activities.

Arthur A. Socolow

NEW OIL AND GAS BASE MAPS AVAILABLE

Four base maps showing locations of oil and gas wells are now available Each base map encompasses four, 15-minute topographic quadrangles and is a the same scale of 1 inch equals a mile. A 5-minute grid, quadrangle name, county boundaries, and major rivers and towns make up the background of the base map. All deep wells known and all shallow wells on record with the Pennsylvania Geological Survey since 1956 are located, and the status (dry, oil producing, gas producing, etc.) are shown by symbol. Deep wells (Tully Formation or deeper are differentiated and elevation and total depth are shown. Symbols indicate the availability of geophysical log and sample data on open file in the Survey's Oi and Gas Division office in Pittsburgh. An index map with the legend shows the outlines of oil and gas fields within the mapped area, thus indicating areas o extensive pre-1956 drilling. A listing of the field names is also included.

Also available at the same scale is a separate map, which superimposes oi and gas field outlines on the base map. This base plus field map is usable fo delineating more accurately and directly areas of extensive pre-1956 shallow wel drilling.

Paper prints of the bases alone or the bases with field limits can be obtained by writing to the Pennsylvania Division of Documents, 10th and Marke Streets, Harrisburg, Pa. 17125. Cost of each base map is $0.50, plus 6 percen state sales tax. A check for the appropriate total amount made out to Commonwealth of Pennsylvania must accompany the order. When ordering please specify the map number. If you wish the map which includes the field outlines, add th letter "A" to the map number.

AVAILABLE BASE MAPS

Designation	Quadrangles Encompassed by Mapped Area
Map 16 or 16A	Corry, Tidioute, Titusville, Youngsville
Map 17 or 17A	Kane, Kinzua, Sheffield, Warren
Map 18 or 18A	Clarion, Foxburg, Oil City, Tionesta
Map 19 or 19A	Brookville, DuBois, Hallton, Marienville

An index showing the location of the completed bases may be obtaine upon request from the Pittsburgh Branch of the Pennsylvania Geological Survey 401 Pittsburgh State Office Bldg., 300 Liberty Ave., Pittsburgh, Pa. 15222. cross index of state permit numbers with quadrangle map numbers used on th base maps is also available from the Survey. This index is arranged by quadrangles. Please specify the quadrangle when requesting this listing.

The Survey will be keeping the base maps continuously up to date. However, to avoid excessive reproduction time and expense, base map prints will be updated only twice a year. In the event there is considerable drilling activity locally during a period, revision of the appropriate map may be more frequent.

The Survey's Base Map Program has received much encouragement from various sources. The distribution of wells and location of areas of production has considerable application outside of the oil and gas industry. Wells drilled represent the only source for subsurface geological-engineering data. Utilization of available subsurface information enables delineation of ground-water potential and near surface water pollution, projection of economic deposits of coal, limestone, clays and other minable, or environmentally important resources into the immediate subsurface, and also the evaluation of subsurface disposal of effluent wastes, potential solution minable salt deposits and economic saline brines. Consequently, the Base Map Program will present to varied industry, government, and individuals locations for sources of subsurface data, or will contain the data that will afford more accurate evaluation of total resources in small or large areas throughout western Pennsylvania.

NEW ENVIRONMENTAL COURSE

Columbia University has introduced a degree-granting program in *environmental science and engineering*. Subjects include ecological imbalance, pollution, resource protection and environmental control. Graduate students of the School of Engineering and Applied Science will be able to earn *master's and Ph.D. degrees* in this field for the first time. They will take courses in eight departments at the Columbia campus including biology, chemical and electrical engineering, geography, geology, and urban planning.

The program will emphasize the broad aspects of man's interactions with his environment, encompassing such studies as ecosystem analysis of relationships between populations and their environments; planning for the use, development and protection of primary resources (air, water, and land); and the development of methods for the control of environments and the restoration of those that have been damaged by human activities.

GEOLOGICAL SOCIETY OFFICER

State geologist Arthur A. Socolow has been re-elected to a second four year term as Secretary-Treasurer of the Northeast Section of the Geological Society of America.

SALTY NEW SALT REPORT

The New York Geological Survey has just published Map and Chart Series Number 12, titled *Stratigraphy of the Upper Silurian Salina Group New York, Pennsylvania, Ohio and Ontario* by Lawrence V. Rickard. This well-organized and illustrated report presents a detailed and comprehensive regional analysis of the underground Salina salt-rich rocks in the Appalachian Basin which comprises portions of Ohio, Pennsylvania, New York and the Canadian Province of Ontario. The 7 figures, 12 plates, 10 maps, 4 geologic cross sections and 3 appendices document the shape, thickness, and distribution of salt as well as the overlying, underlying, and adjacent rocks of the salt basin.

The report was developed from an examination of well cuttings and gamma-ray logs from 435 deep wells. The subsurface geology developed from these deep wells is tied to the surface salt section which is exposed along the northern portion of the basin.

This New York report, Map and Chart Series Number 12, is available from the New York State Museum, Albany, New York for $5.00, payable to the New York State Education Department.

The New York Geological Survey effort complements the published reports of the Pennsylvania Geological Survey which have treated the Salina salt

The Pennsylvania publications include the following:

Cate, A.S. 1961, **Stratigraphic Studies of the Silurian Rocks of Pennsylvania Part 1;** Pa. Topo. and Geol. Survey, Spec. Bull. 10. $1.75.

______, 1965, **Stratigraphic Studies of the Silurian Rocks of Pennsylvania, Part 2;** Pa. Topo. and Geol. Survey, Spec. Bull. 11. $2.10.

Fergusson, W.B. and Prather, B.A. 1968, **Stratigraphy of the Salina Group in Pennsylvania:** Pa. Topo. and Geol. Survey, Mineral Resources Rept. M 58. $0.55.

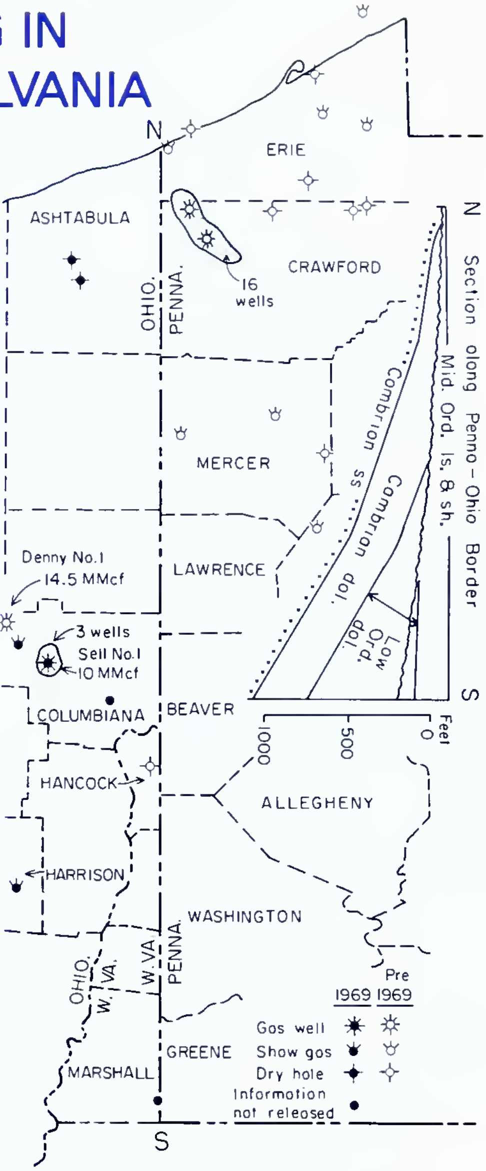
Fettke, C.R. 1955, **Preliminary Report Occurrence of Rock Salt in Pennsylvania:** Pa. Topo. and Geol. Survey Prog. Rept. 145. $0.25.

These Pennsylvania Geological Survey publications may be ordered fro Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125, wit payment, plus 6 percent state sales tax.

HOW ABOUT SCOTCH ON THE ROCKS

At the recent International Symposium on the Hydrology of Glacie scientists of the U.S. Geological Survey and the U.S. Army proposed the pos bility of towing icebergs to communities that face a fresh water shortage. Wha sight they would be, sailing up the Delaware, Ohio, and Susquehanna Rivers.

FUTURE DEEP DRILLING IN PENNSYLVANIA



Successful gas exploration in the Cambrian and Lower Ordovician rocks in eastern Ohio may be the impetus for renewed deep drilling to these strata in Pennsylvania.

Interest was ignited in 1968 by the initially reported potential of 14.5 million cubic feet of gas per day discovered in the Cambrian and Lower Ordovician dolomites at a depth of 8,094-8,114 feet, in Columbiana County, Ohio (Denny No. 1, East Ohio Gas, see Figure). During 1969, eight wells were reported in easternmost Ohio and one was drilled in Marshall County, West Virginia less than 1 mile from the Pennsylvania border. One of the wells (Sell No. 1, Tri-State Producing), also in Columbiana County, reported an initial potential of 10 million cubic feet of gas per day from the dolomite.

The gas traps are related to permeable zones below a regional unconformity extending across Ohio and western Pennsylvania (see Figure). Above the unconformity lie Middle Ordovician limestones and shales, and below it are Lower Ordovician dolomites and Upper Cambrian dolomites and sandstones which thin to the north and west.

In Erie and Crawford Counties, Pennsylvania, two wells drilled into Cambrian sandstones underlying the unconformity produced gas. In Columbiana County, the gas-producing dolomite lies between the sandstone and the unconformity, the dolomite disappearing by truncation in northwestern Pennsylvania and northeastern Ohio. Thus gas production appears to be related to the lithology that lies below the unconformity.

The gas in Ohio holds promise of production for Pennsylvania because the Ohio Cambrian and Lower Ordovician rocks with their attendant porous and permeable reservoir zones extend eastward into Pennsylvania. In the northwestern counties, wells reaching this interval have consistently yielded shows of gas, salt water, or both. In the southwestern part of the state, no well has yet been drilled deep enough, but from the Columbiana County information that has been released, the only difference between Pennsylvania and Ohio is a deeper depth in Pennsylvania—10,000 feet in Beaver County, 12,000 feet in Allegheny County, and 14,000 feet in Greene County. In addition, Pennsylvania offers a thicker sequence of dolomites to explore.

SURVEY REPORTS ANSWER MANY QUESTIONS

CAN WE BUILD HERE?
IS THE FOUNDATION STABLE?
WILL [illegible] INVOLVE ADDED COSTS?
IS IT SAFE?

BEFORE CONSTRUCTION, DETAILED GEOLOGIC FOUNDATION INVESTIGATIONS WILL SHOW WHERE SINKHOLES AND CAVES EXIST

STRUCTURES MAY BE DESIGNED TO FIT THE SITUATION

HIGH COSTS OF FUTURE MAINTENANCE MAY BE REDUCED

Alan R. Geyer
William G. McGlade
Environmental Geology Division

RAIN WATER NOT SO PURE

Rain or snow that reaches the earth on the eastern United States is far from "pure" water, according to chemical studies by a hydrologist of the U.S. Geological Survey.

Research chemist, D. W. Fisher, said that water from precipitation falling over relatively contaminant-free areas, contains some sea salts, sodium-calcium bicarbonates, and sulfuric and nitric acids.

The rain and snow over the northeast have acid components while the precipitation in the marine environment around St. Thomas is on the salty side. Sea salts and bicarbonates predominate close to the mid-Atlantic coast.

To gather the precipitation samples, Survey hydrologists set up a network consisting of 52 collection stations. The stations were selected to obtain representative samples in relatively uncontaminated areas.

While almost all the selected sites are located in sparsely populated areas, two sites – one at Norfolk, Virginia, and one at the airport in Albany, New York were chosen to provide comparative data from urban areas. At these sites, high calcium and sulfate concentrations appear to be the most noticeable effect of the urban-industrial atmospheres on precipitation quality.

The Survey scientist reported that on St. Thomas, average levels of sodium, chloride, and bicarbonate in precipitation are about 5, 7, and 11 parts per million, respectively.

In continental rainfall sulfate is quite noticeable. Concentrations of sulfate in eastern North Carolina are about 2.3 ppm, and are about 4.7 ppm in rural upstate New York. At these concentrations, precipitation will dump about 7 tons of sulfate per square mile on North Carolina annually, and about 14 tons per square mile on New York State, assuming about 40 inches of rainfall for the year.

MEASURING LANDSCAPE APPEAL

A numerical method for determining landscape "appeal" has been proposed by Dr. Luna B. Leopold, senior research scientist with the U.S. Geological Survey. By assigning numerical values to salient characteristics of landscapes, environmentalists would have a measuring tool for judging landscape esthetics dispassionately, without relying on subjective judgment, dollar value, or sentimental appeal. Such a system would provide a potential statistical framework for successful planning and decision making.

Leopold's system is based on a "uniqueness ratio" – obtained by assignment of values to landscape characteristics, including the physical, biological, and human interest features it offers. A list of 46 items compiled to describe a river valley included such factors as "erosion of river banks," "water color," "trash and litter," "vistas," and "urbanization".

By making a factor-by-factor comparison, landscapes can be evaluated for their relative uniqueness.

WATER USE

The Nation as a whole receives an average of about 30 inches of precipitation annually; that is, the annual fall, if it were possible to accumulate, would cover the whole country to a uniform depth of about 2½ feet. Almost three-fourths of the total precipitated water is returned to the atmosphere by evaporation and transpiration (plant-breathing). The remaining one-fourth contributes to runoff in streams, and ground-water storage, and constitutes the water available for withdrawal use. This available quarter can be expressed as an average yield of 1.3 trillion gallons per day. This is equivalent to about 7,500 gallons each day for every man, woman, and child in the country. This latter amount is about what could be stored in a cubical box 10 feet on a side.

Though we think of water use in the home as the principal reason for having a municipal system, the largest use of water from municipal systems is by industry. There are many industrial plants which find it more economical to buy water from the city than to provide individual supplies from wells or reservoirs. The average water use for industrial purposes from public supplies can best be stated in relation to the population of the city. Average use by commerce and industry is about 70 gallons per capita per day.

Domestic use of water refers to the use of water in the home for drinking, cooking, washing clothes and dishes, and bathing. A second principal use is for toilet flushing, and a third is lawn and garden sprinkling. The average use per person in an American home varies between about 20 to 80 gallons per day. Listed below are some typical figures on the amount of water necessary for certain home operations:

Flush a toilet	3 gallons
Tub bath	30 to 40 gallons
Shower bath	20 to 30 gallons
Wash dishes	10 gallons
Run a washing machine	20 to 30 gallons

Water used for normal household purposes is not consumed; most is put into the surface streams through sewerage systems. Municipal and industrial uses are considered generally nonconsumptive because of such return in contrast to irrigation, which is the largest consumptive use. Much irrigation water is transpired to the atmosphere as vapor by plants or evaporated from the soil, thus the water is consumed, or lost to immediate future use by man.

Water use varies during the day and during the week in a way to reflect interesting details of American home life. Use is, of course, low during the night but increases rapidly to a maximum between 8 and 9 o'clock in the morning. Another peak use occurs at dinner time between 6 and 8 o'clock in the evening. Though there is variation in maximum peak between cities, this difference is interpreted to mean that more people take baths and showers in the morning than at bedtime. Also, an extra heavy peak occurs on Saturday night in many cities; so it appears that the Saturday night bath is still a reality.

IN THE NATION

Besides domestic and industrial uses, there are two other main classes of water use of municipal supplies. The first, public use, includes fire extinguishing, street cleaning, public-building use, and maintenance of public parks. This accounts for about 10 gallons per capita per day. The second class of water consumption in a city is loss of unaccounted-for waste. Leaks from water mains and unmeasured leaks from faucets, as well as errors of measurement appear to contribute to this loss. This item is amazingly large, and even careful construction and management cannot reduce it to less than 20 percent of the total use.

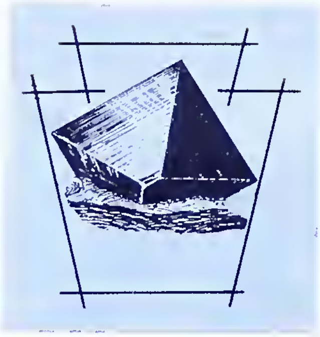
In total, the average use of water per capita in American cities (domestic, industrial, public, etc.) now exceeds 150 gallons per day, having risen progressively with the increase in industry. In 1920, the average use was only about 115 gallons per capita per day; more than a 30 percent increase has taken place in the last 40 years.

Annual use of water in the United States, excluding waterpower, may be summarized as follows:

		Total withdrawn (million gallons per day)		*Percent*
Public supplies		17,000		7
Rural use		3,000		1
Irrigation:				
Delivered to farms	81,000		34	
Lost from canals	29,000		12	
Total Irrigation		110,000		46
Self-supplied industrial		110,000		46
Total		240,000		100

The United States is in the happy circumstance of being well supplied with water. After nature takes its share of water which falls as precipitation, there is available for man's use about 7,500 gallons of water per day for every citizen in the country. Of this available water, we presently use about 1 gallon out of every 5. In a national sense, then, the country is not likely to run out of water in any foreseeable future. But because water is not uniformly available in various parts of the Nation, it is necessary to bring water from places of excesses to places of shortage. Such transport of water, whether in river channels, canals, or pipes, costs money. There is an economic limit involving movement of water to places where it is in short supply. In this sense, then, available water is limited principally by how much any area or group can afford to spend to increase its local supply. Where water is in short supply, obviously, conservation is both desirable and necessary. Conservation means minimizing useless water waste and applying available water to those uses which give the greatest social and economic benefit.

From "A Primer on Water", which is available through the Government Printing Office, Washington, D.C., 20402 for 35 cents per copy.



EARTH SCIENCE TEACHERS' CORNER

PENNSYLVANIA EARTH AND SPACE SCIENCE REVISION

The current approach to the teaching of Earth and Space Science retains the philosophy that this is a course for all students. The new writing team, under the direction of the Bureau of General and Academic Education of the Department of Education, feels strongly that Earth and Space Science is a course that is of great value to students of all abilities. With this thought in mind it becomes essential that the stimulation of interest must be placed high on the list of objectives for the course.

As an example of the concern for student interest, the new guide will begin the study of geology with a discussion of landforms which the pupils can observe in their own immediate area rather than the former treatment of the materials of which the earth is composed. A series of questions which the teacher might ask is designed to lead the students to the realization of the differences between landforms and then to an awareness of the fact that these differences are related to variations in materials and processes which operate over periods of time. The logic of beginning the study of geology with the surface features of the earth is that all students have some firsthand knowledge of surface features and can observe them in their home areas.

The revised teaching guide is expected to be available in September of 1970.

SPACE SCIENCE SLIDES AVAILABLE

"Focus From Outer Space," a set of 24 color slides (35mm) of the most spectacular NASA photographs from the Gemini and Apollo programs is available for $3.50 from the Advertising Department, Carl Zeiss Inc., 444 Fifth Avenue, N.Y., N.Y.,10018. Twelve of the set of 24 are from the recent Apollo 11 mission to the moon. The slides come in a small booklet with each identified and documented. Payment must accompany your order.

U. S. GEOLOGICAL SURVEY'S LEAFLET SERIES

Several new U.S.G.S. Leaflets have been added to this popular geology series. *"Geologic Maps, Portraits of the Earth"* is 19 pages in length and describes how to make geologic maps, what they show, and how they are used.

"Why Is The Ocean Salty?" is a 15-page leaflet describing why the sea is not fresh, the chemistry of sea water, the variability of salinity in the sea, how sea life affects sea water's composition, the origin of the sea, and the source of the salt.

The U.S.G.S. displayed a specimen of moon rock at the Geological Society of America's annual meeting in November. Accompanying this display was an excellent new pamphlet titled, *Steps To The Moon.* This 35-page booklet describes views of the moon, its craters, the maria, and pictures from Apollo 8, 10, and 11. The booklet is an excellent reference for your library and your students.

These leaflets and booklet are free of charge; write to the Information Office, U.S. Geological Survey, Washington, D.C., 20242.

NEW SPACE FILMS

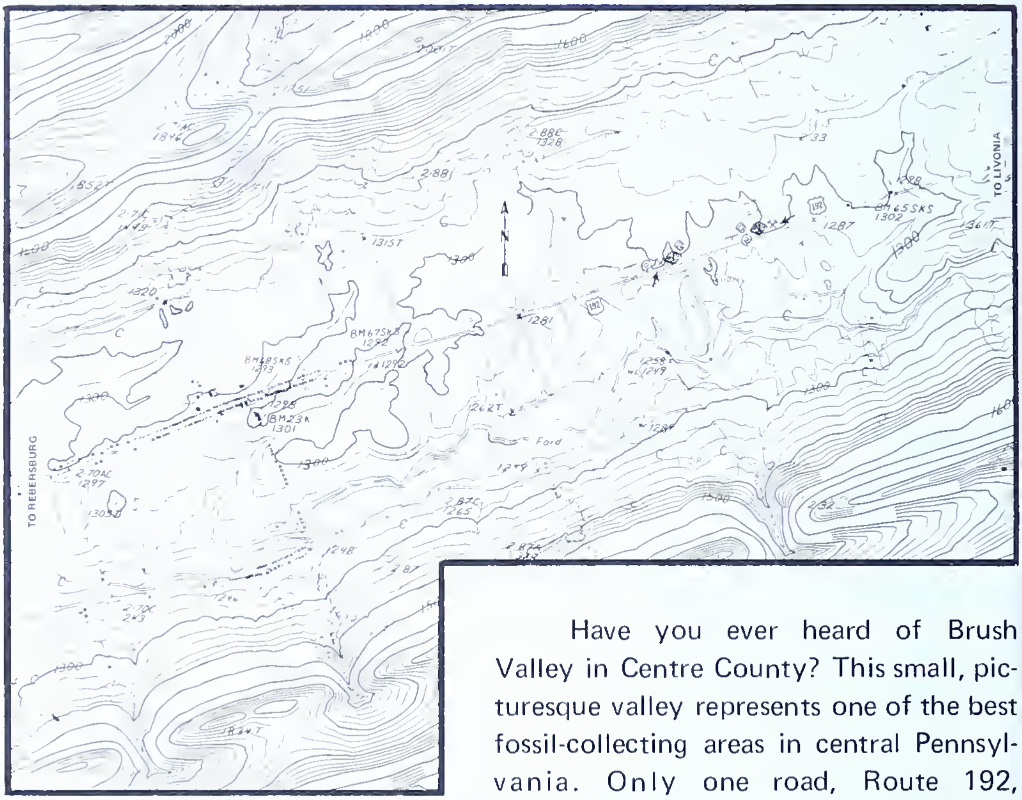
Apollo 11 for All Mankind is a special film available from NASA. This is an excellent documentary on the flight of the Apollo 11 spacecraft. Superb photographs of the moon from the command module as well as from the LEM are included. The film is in color and is approximately 30 minutes in length.

The Eagle Has Landed – Flight of Apollo 11 documents the Apollo 11 mission from the launching of the Saturn V-Apollo vehicle on July 16, 1969, through the lunar landing on July 20, 1969, and the return of the astronauts Armstrong, Aldrin and Collins. It is in color and is 29 minutes in length. This film is available from The Film Center, 915 12th Street, N.W., Washington, D.C., 20005.

GEOLOGY SLIDES AVAILABLE

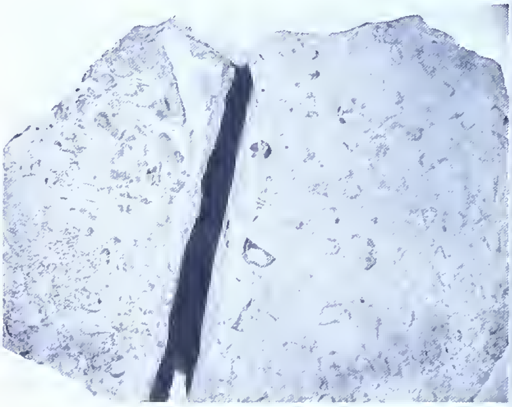
A complete earth science series of slides that provides coverage of all the areas of physical geology is now available at a relatively low cost. The slides are arranged in sets dealing with glaciers, rivers and ground water, mountains, vulcanism, diastrophism and topographic maps. For further information write to: Balkwill Color Slides, 1423 Twelfth Ave., Grafton, Wisconsin 53024.

FOSSILS GALORE



Have you ever heard of Brush Valley in Centre County? This small, picturesque valley represents one of the best fossil-collecting areas in central Pennsylvania. Only one road, Route 192, traverses this valley between Rebersburg and Livonia and midway between these two communities can be found some fabulous fossil remains of an Ordovician sea. Most of the fossils can be found in two large road cuts where the layers of limestone are exposed. Ample parking is available at these road cuts and traffic along Route 192 is light. In general, this is an ideal spot to stop and collect.

Excellent specimens of some brachiopods, bryozoans, trilobites, and crinoids may be found. Careful collecting will turn up many smaller fossils and some that have weathered free of the enclosing limestone.



The limestone exposed here is called the Nealmont Formation and is Upper Ordovician (425 million years ago) in age. Some layers of this limestone are almost entirely fossil hash.

Alan R. Geyer

SURVEY ANNOUNCEMENTS

NEW LIMESTONE AND DOLOMITE MAP

A new two-color map issued by the Pennsylvania Geological Survey shows the distribution of limestone and dolomite rocks in Pennsylvania. Map Number 15, prepared by William G. McGlade of the Survey Staff, is 12" x 18" and is available free upon request from the Survey. In Pennsylvania, limestones and dolomites usually contain abundant ground-water supplies. They are also an important mineral resource in providing crushed stone for construction and road building, as well as raw material for cement and lime. On the other hand, carbonate rocks may present hazards and construction problems because of the development of "sinkholes" and other forms of solution cavities. So the key words for carbonate rocks are: MINERAL RESOURCE - FAVORABLE GROUND WATER SUPPLY - POTENTIAL ENGINEERING PROBLEM.

Publications of the Pennsylvania Geological Survey which refer to carbonate rocks of Pennsylvania are listed on the reverse side of the new map; these publications can be useful in detailing particular areas of interest.

PENNSYLVANIA PLATEAU PRECAMBRIAN ROCKS

The oldest rocks found at the surface in Pennsylvania occur in the southeastern part of the State. However, these rocks, known as Precambrian, also occur at great depth below the present surface throughout the State. Several holes were drilled in Erie, Mercer, and Crawford Counties which penetrated this old Precambrian rock at depths of from more than 1 mile to almost 2 miles.

The location and geologic description of these drill-hole samples was reported recently by Timothy E. Saylor in a new publication, *The Precambrian in the Subsurface of Northwestern Pennsylvania,* Pennsylvania Geological Survey Information Circular 62. The rock types found and described are granite pegmatite, granitic schist, biotite phyllite, quartz-biotite gneiss, a hornblende-bearing gneiss, and a granite gneiss. These rocks are at least 600 million years old, and may be as old as 1,100 million years. Mr. Saylor correlates them with similar rocks found beneath the surface in Ohio and West Virginia.

Information Circular 62 is available for $0.45, plus 6 percent state sales tax, from the Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125.

WOY WOY, AUSTRALIA

One of the functions of the Mineral Resources Division of the Survey is to provide Pennsylvania rock and mineral specimens to museums upon request. Usually such requests come from Pennsylvania; occasionally we receive them from other states. However, as the uniquely interesting geology of Pennsylvania becomes better known, more and more institutions from outside the United States have been writing for representative samples that range from unusual minerals like zeolites to representative common rocks such as schist. In the past year, samples have been sent to Canada, London, England, and Scotland.

Perhaps the most far-reaching request was received this fall from Woy Woy, N.S.W., Australia. Miss Jane Campbell, Curator of the Gloria Maris Museum there, was seeking good specimens of rocks, minerals and fossils from the United States for the education of primary and high school students. She selected Pennsylvania to obtain these specimens and we are proud to have been able to be of assistance. Samples sent representing Pennsylvania industries included anthracite coal of which Pennsylvania is the nation's major producer, hard clay used in the manufacture of ceramics, and limestone used in cement manufacture. Some of the rare minerals included the hydrocarbon, grahamite, that is often called jet, magnetite from the world-famous iron mine at Cornwall, and large cubes of pyrite ("fool's gold") altered to limonite ("yellow rust") from Columbia. Typical rocks and a gastropod ("snail") fossil also were included, totaling 15 in all.

In reply, Miss Campbell wrote, "We have now placed your interesting specimens in a prominent position in the Mineral Room". The Pennsylvania Geological Survey is pleased to have contributed to the geological education and viewing interest of our distant neighbors from "down under". If you are travelling to Australia, or to any foreign country, take a look in the museums. You may be surprised to see some minerals from "back home" in Pennsylvania.

SUBSURFACE BRINE ANALYSES AVAILABLE

The Pennsylvania Geological Survey has compiled all available subsurface brine analyses of the state. These have been placed on open-file and are available for examination by anyone interested. Such data are useful in evaluation of subsurface geophysical logs, compatability to fluids in disposal and secondary and tertiary reservoir treatment, potential for commercial extraction of salts and related brine chemicals, and determining sources of possible pollutants resulting from drilling activity.

Analyses of the deep formation brines (Tully and deeper) have been grouped by source horizon and tabulated. An index map of the analyzed samples is available for reference at the Pittsburgh office. The tabulation, as well as the original analyses may be examined. Analyses of the shallow formation brines (those from horizons above the Tully) have been assembled in the groups designated in the recently released shallow type logs of western Pennsylvania (Progress Report 178).

The analyses may be examined at the Pittsburgh Office of the Pennsylvania Geological Survey, Room 401 Pittsburgh State Office Bldg., 300 Liberty Ave., Pittsburgh, 15222.

PENNSYLVANIA'S PEAT DEPOSITS

A detailed description of the nature and occurrence of peat deposits in Northeastern Pennsylvania is contained in a new publication of the Bureau of Topographic and Geologic Survey. Entitled *Peat Bog Investigations in Northeastern Pennsylvania,* by Curtis Edgerton, the report includes analyses, maps, and illustrations of major, undeveloped peat bogs in Pike, Wayne, Susquehanna, Lackawanna, and Luzerne Counties. Cross sections and isopach maps of the individual peat bogs give a clear picture of their potential.

It is hoped that a greater awareness of the nature of peat occurrences in Pennsylvania and of the large reserves yet undeveloped will stimulate economic development of this outstanding resource. Pennsylvania is already the sixth largest peat producer in the nation and could readily advance its rate of production.

Information Circular 65, *Peat Bog Investigations in Northeastern Pennsylvania,* is available for $0.85, plus 6 percent state sales tax, from the Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125.

CALENDAR OF EVENTS

The Pennsylvania State University Geological Sciences Seminar

February 24	R.T. Faill, Pennsylvania Geological Survey, "Kink Band Deformation in the Valley and Ridge Province"
March 3	T.P. Thayer, U.S. Geological Survey, "Chromite Deposits and Peridotite Petrology
April 7	B. Hanshaw, U.S. Geological Survey, "Radiocarbon Dating of Ground Water and Its Geochemical Implications"
April 14	J. McCauley, U.S. Geological Survey, "Geology of the Near Side of the Moon"

MINERAL-COLLECTING CLUBS

Mineral collecting is a fast-growing hobby that appeals to a wide range of interests and spans the "generation gap" from children to adults. Besides the interests of amateur and professional mineralogists, it offers enjoyment of the outdoors and trips to unusual places, a chance for the artist and the craftsman in gem-cutting to create new jewelry, and for the adventurer in us all, an opportunity to explore the unknown. For these people many societies have sprung up throughout the Commonwealth. They offer an excellent opportunity for people with similar interests to get together for discussions, lectures, demonstrations, swap-sessions, and field trips. If you are interested in this fascinating hobby, there probably is a club not far away from you. Contact them and they will welcome you to their group. For your convenience, a list of these societies is provided.

EASTERN PENNSYLVANIA

The Berks Mineralogical Society, Inc.
Nancy Weiser, Editor "The Berks Geode"
329 Chestnut St.
Reading, Pa. 19602

Bucks County Gem Cutters Guild
Box 111
Solebury, Pa. 18963

Che-Hanna Rock & Mineral Club
c/o Florence Lines, President
R.D.1
Monroeton, Pa. 18332

Central Pa. Rock & Mineral Club, Inc.
Donald Seiders, President
218 E. Willow St.
Elizabethtown, Pa. 17022

Delaware Valley Earth Science Society, Inc.
c/o Mrs. Frieda Regensburg, Secretary
123 Spruce St.
Audubon, N.J. 08106

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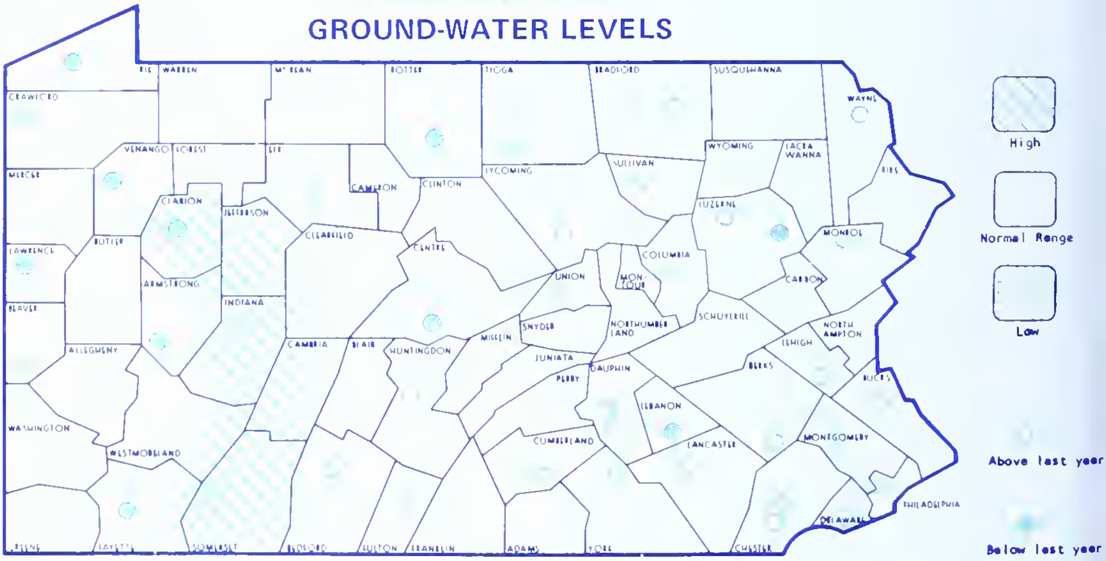
GROUND-WATER LEVELS



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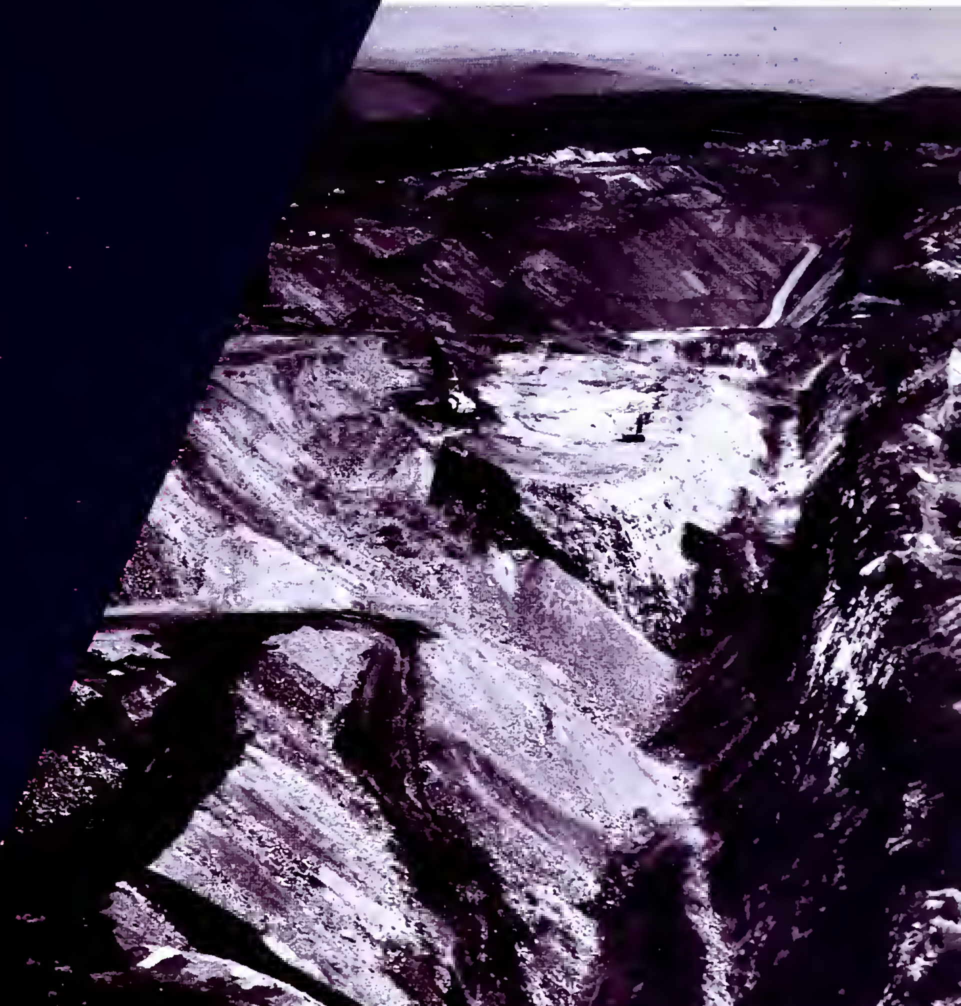

THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 1/5

COMMONWEALTH OF PENNSYLVANIA
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Topographic and Geologic Survey
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CONTENTS

The State Geologist Reports 1
Ground Water Program in Pennsylvania 2
Water Resource Reports Available 5
Water Well Records Go to Computer 7
Fault Near Hazelton 9
The Survey Library 11
Tanzanite: The New Gem Stone 12
New Sample Library Facilities 13
Earth Science Teacher's Corner 14
Survey Announcements 15

ON THE COVER — View of anthracite strip mining operations illustrating the magnitude of environment restoration problems.

Photo by Grant Heilman

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

APRIL 1970

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

THERE'S WATER IN OUR FUTURE

Based on its vital role to all life, as well as its importance to industry, water is Pennsylvania's most valuable mineral resource. With a growing population and an increasing industrial demand, the Commonwealth faces a continuing need to develop its water resources. The study and inventory of that major portion of water which is located in the rocks beneath the surface of the earth, known as ground water, is a mandated responsibility of the Bureau of Topographic and Geologic Survey. The Survey has been involved with ground-water studies for over 50 years and has an extensive list of resulting ground-water publications as well as a proud record of services to citizens and fellow government agencies. Two following articles in this issue of the bulletin enumerate these ground-water activities of the past and present. Our ground-water data is developed in part by detailed area studies conducted with the cooperation of the United States Geological Survey, and in part by incoming data from new water wells. The latter is a direct product of the Survey's mandated role as licensing agent for the Commonwealth's water well drillers; the cooperation of the water well drillers in supplying accurate ground-water data from their wells is thus an important input in the study of our ground water.

It should be noted that ground-water studies involve considerably different criteria than surface water studies. Since the ground water occurs in rocks, the physical and chemical properties of the rock formations, as well as the extent and position of the rock formations are critical. A single drainage basin may be underlain by scores of different rock types, each with its own water-yielding capabilities. Ground-water studies of a region, therefore, commonly progress at a slower rate than do surface-water studies.

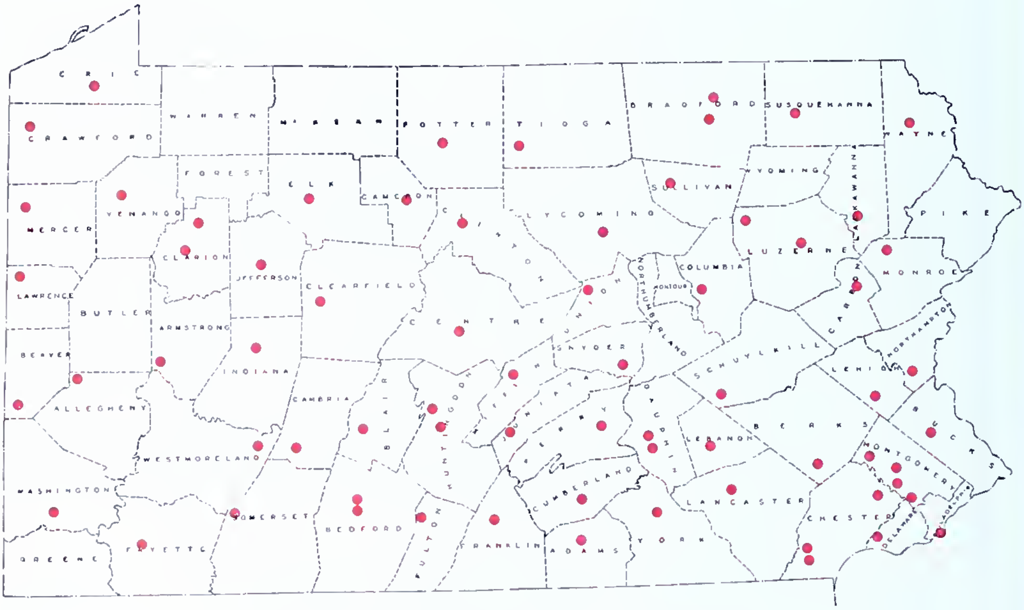
To coordinate its program of ground-water investigations with surface and water quality programs being carried out by other state agencies, the Survey participates in the State Water Resources Coordinating Committee. This unit actively serves as a communications and coordinating center for all state agencies in any way involved with water activities in the Commonwealth.

With growing need for water quantity, and growing concern for water quality, the Survey looks to maintaining a ground-water program responsive to the present and future needs of the Commonwealth.

Arthur A. Socolow

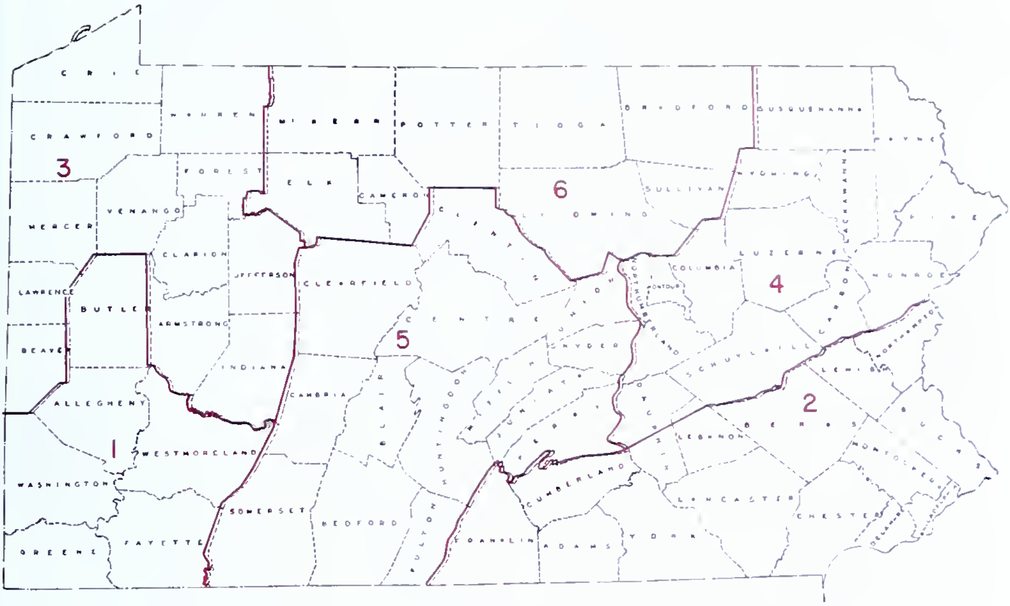
GROUND WATER PROGRAM IN PENNSYLVANIA

The Pennsylvania Geological Survey has been engaged in ground-water studies for nearly 50 years. A cooperative agreement between the Pennsylvania Geological Survey and the Ground Water Branch of the U.S. Geological Survey was initiated in 1925 whereby the latter was to conduct ground-water investigations throughout the Commonwealth; the program has been in continuous existence ever since. In 1930, a state-wide network of observation wells was established. This network was designed to determine the long-term trends of ground-water levels in areas largely unaffected by local withdrawals from wells. This study has been kept current and in recent years greatly expanded to include nearly every county in the state.



Observation Wells in Pennsylvania

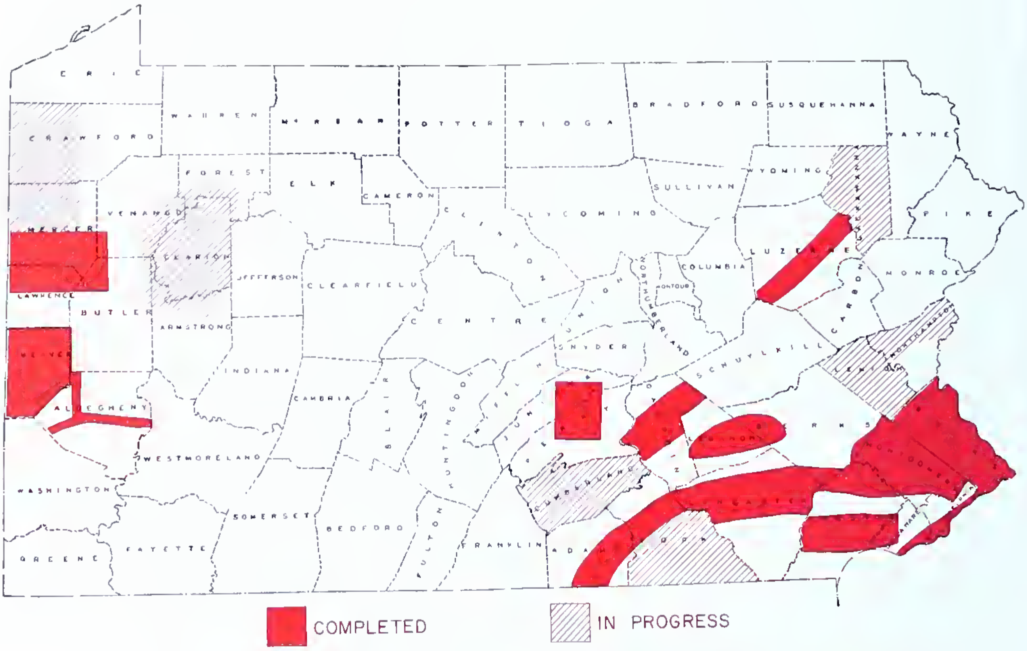
By 1940, a series of six ground-water reports, covering the entire Commonwealth, was published. These ground-water reports, Bulletins W-1 to W-6, describe the geological and ground-water conditions for each county and have a tabular listing of several well records per county. Despite their early printing, they are still widely used, and provide the reader with a quick summary of ground-water conditions of each county.



Index of Regional Reports

Since 1943, the cooperative program between the Pennsylvania and the United States Geological Survey has expanded steadily with the recognition of the importance of ground-water supplies to Pennsylvania. This newly intensified cooperative program marked the beginning of a systematic program of detailed local ground-water studies. Four major ground-water reports were forthcoming during the period 1945 to 1955. These reports were systematic detailed studies of the hydrology of the important ground-water aquifers that occur in Pennsylvania.

As the science of hydrology advanced during the latter part of the 1950's and through the 1960's, new techniques and tools evolved. Our geologists and engineers were able to apply these new methods of testing and studying Pennsylvania's ground-water aquifers with a net result that the Pennsylvania Survey was able to publish highly detailed and accurate ground-water reports during this period. The Survey accomplished studies of ground water in each of the widely different physiographic and geologic provinces of the State. The eighteen major detailed ground-water reports finished between 1960 and 1970 were concerned with the occurrence and movement of ground-water in each of these different geologic regions. Every region and each rock formation within the region have special characteristics that must be defined and that ultimately provide the clues to the quantity and quality of ground water available. The principal objectives in these reports are the determination of total well yield, well depth, depth of water-bearing zones, depth of weathering, and the chemical quality of the water as each of these factors relates to geologic structure, rock type, and topographic position of the well.



Detailed Ground-Water Studies

Today, the Pennsylvania Geological Survey's ground-water reports have taken on a new look, designed to be readily understood even while being more comprehensive. Each comprehensive report includes a ground-water availability map. For this type of map a full-color scheme is used that is based on the water-bearing ability of the rock units. The brighter the color, the better the water-supply potential. These maps and reports are easily read and readily understood by regional, county and municipal planners, consultants, and others who must develop and manage Pennsylvania's water resources.

Today, the ground-water activities of the Pennsylvania Geological Survey are broader than ever before. An expanded program of ground-water services to fellow state agencies, local communities, and the general public is heavily utilized. The data being collected from water well drillers is more effectively analyzed and utilized than ever before. The cooperative program with the U.S. Geological Survey Water Resources Division is at a peak level, with the latter agency operating out of Harrisburg, with a staff of 16 working on ground-water projects in various parts of the State (see map).

For the future, a growing demand for water, as well as a growing concern over the pollution of surface water, will result in increasing use and need for ground-water resources in Pennsylvania. In recognition of this trend, the Pennsylvania Geological Survey and the United States Geological Survey have planned for increasing detailed inventories of the ground-water resources of Pennsylvania and increasing services to the water users of the Commonwealth.

WATER RESOURCE REPORTS

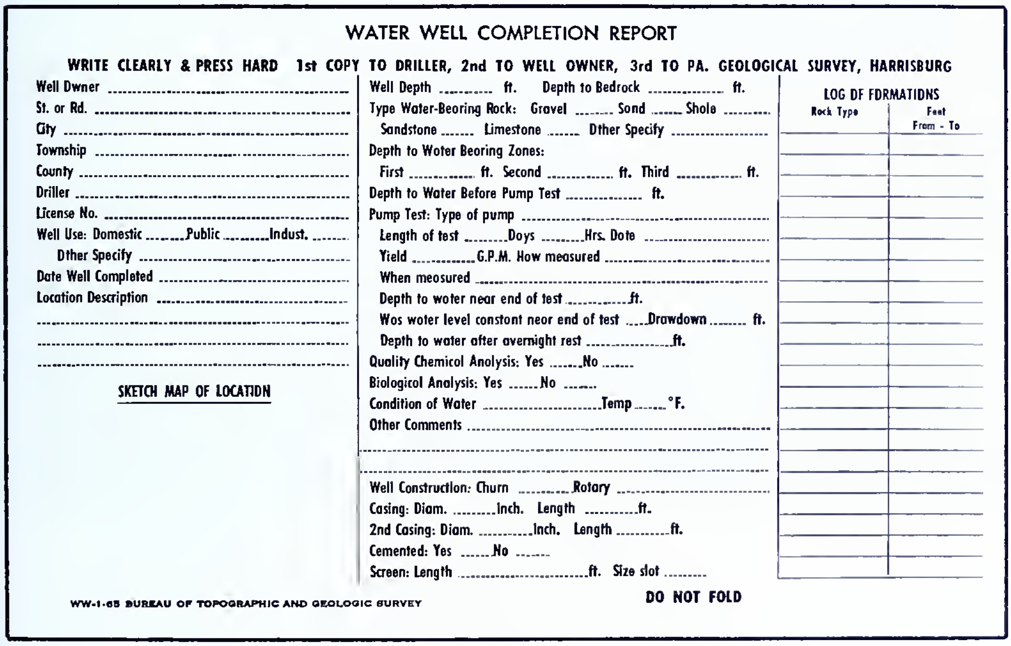
DIVISION OF DOCUMENTS
10th and MARKET STREETS
HARRISBURG, PENNA. 17125

W	1	**Ground water in southwestern Pennsylvania,** by A.M. Piper. 1933. 410 p., 40 figs.	$1.50
W	2	**Ground water in southeastern Pennsylvania,** by G.M. Hall. 1934; 2nd printing, 1967. 255 p., 7 fig., 7 pls	4.85
W	3	**Ground water in northwestern Pennsylvania,** by R.M. Leggette. 1936; 2nd printing, 1957. 215 p., 15 fig., 9 pls	3.20
W	4	**Ground water in northeastern Pennsylvania,** by S.W. Lohman. 1937; 2nd printing, 1957. 300 p., 18 fig., 7 pls	2.70
W	5	**Ground water in south-central Pennsylvania,** by S.W. Lohman. 1938; 2nd printing, 1968. 315 p., 11 fig., 19 pls	5.00
W	6	**Ground water in north-central Pennsylvania,** by S.W. Lohman. 1939; 2nd printing, 1967. 220 p., 13 fig., 11 pls	4.20
W	7	**Ground-water resources of Pennsylvania,** by S.W. Lohman. 1941. 32 p., 11 fig., 1 pl	0.25
W	8	**Ground-water resources of the valley-fill deposits of Allegheny County, Pennsylvania,** by J.H. Adamson et al. 1949. 181 p., 9 figs., 5 pls	1.85
W	9	**Ground-water resources of Beaver County, Pennsylvania,** by D.W. VanTuyl and N.H. Klein. 1951. 84 p., 11 fig., 1 pl	1.50
W	10	**Ground water for air conditioning at Pittsburgh, Pennsylvania,** by D.W. VanTuyl. 1951. 34 p., 9 figs.	0.50
W	11	**Ground-water resources of Bucks County, Pennsylvania,** by D.W. Greenman. 1955. 67 p., 1 fig., 2 pls.	3.75
W	12	**Borehole geophysical methods for analyzing the specific capacity of aquifers in a multiaquifer well,** by G.D. Bennett and E.P. Patten. 1960. 27 p., 8 figs.	0.15
W	13	**Ground-water resources of the Coastal Plain area of southeastern Pennsylvania,** by D.W. Greenman et al. 1961. 375 p., 27 fig., 22 pls.	9.10
W	14	**Geology and hydrology of the Stockton Formation in southeastern Pennsylvania,** by D.R. Rima, Harold Meisler, and Stanley Longwill. 1962. 11 p., 8 tables, 4 pls.	4.45
W	15	**Geology and hydrology of the Neshannock quadrangle, Mercer and Lawrence Counties, Pennsylvania,** by L.D. Carswell and G.D. Bennett. 1963. 98 p., 8 figs., 3 tables, 4 pls.	4.00

W	16	**Geology and hydrology of the Mercer quadrangle, Mercer, Lawrence, and Butler Counties, Pennsylvania,** by C.W. Poth. 1963. 149 p., 24 figs., 6 tables, 5 pls.	4.95
W	17	**Methods of flow measurement in well bores,** by E.P. Patten, Jr. and G.D. Bennett. 1963. 28 p., 13 figs., 1 table. Available as U.S.G.S. Water-Supply paper 1544c	
W	18	**Hydrogeology of the carbonate rocks of the Lebanon Valley, Pennsylvania,** by Harold Meisler. 1963. 81 p., 18 fig., 3 tables, 3 pls.	3.55
W	19	**Application of electrical and radioactive well logging to ground-water hydrology,** by E.P. Patten, Jr. and G.D. Bennett. 1963. 60 p., 11 figs.	0.25
W	20	**The ground-water observation-well program in Pennsylvania,** by C.W. Poth. 1963. 17 p., 8 figs.	0.25
W	21	**Hydrology of the New Oxford Formation in Adams and York Counties, Pennsylvania,** by C.R. Wood and H.E. Johnston. 1964. 66 p., 10 figs., and geologic map.	2.15
W	22	**Hydrology of the Brunswick Formation in Montgomery and Berks Counties, Pennsylvania,** by S.M. Longwill and C.R. Wood. 1965. 59 p., 13 figs., and geologic map.	1.75
W	23	**Hydrology of the New Oxford Formation in Lancaster County, Pennsylvania,** by H.E. Johnston. 1966. 80 p., 11 figs., and geologic map.	1.50
W	24	**Geology and hydrology of the Martinsburg Shale in Dauphin County, Pennsylvania,** by L.D. Carswell, J.R. Hollowell, and L.B. Platt	2.30
W	25	**Hydrology of the metamorphic and igneous rocks of central Chester County,** by Charles W. Poth. 1968. 84 p., 29 figs., 3 pls.	4.50
W	26	**Hydrology of the carbonate rocks of the Lancaster 15-minute quadrangle,** by H.E. Johnston	(in press
W	27	**Hydrology of the Loysville and Mifflintown quadrangles,** by H.E. Johnston	(in press
W	28	**Geology and hydrology of the Wyoming Valley,** by J. Hollowell	(in press
W	29	**Ground water summary of Montgomery County,** by T. Newport	(in press
PR	146	**Ground-water resources of the Lansdale area,** by D.R. Rima. 1955. 25 p., 4 figs., 7 pls.	0.4
PR	171	**Hydrology of the carbonate rocks of the Lancaster 15-minute quadrangle, Pennsylvania,** by Harold Meisler and A.E. Becher. 1966. 36 p., 7 figs., 1 pl.	1.1

WATER WELL RECORDS GO TO THE COMPUTER

Since 1966, the Bureau of Topographic and Geologic Survey has been receiving water well completion records for individual wells from Pennsylvania's licensed water well drillers. Prior to that date and back to 1956 (the date of the Water Well Drillers Licensing Act), the drillers were required to keep the well completion forms in their personal files, subject to request by the Geologic Survey. Each "Water Well Completion Report" form contains valuable information on Pennsylvania's water resources. Well depth, depth to bedrock, type of water-bearing rock, depth to water-bearing zones, water table depth, drawdown values, and quality of water are among the most important information found on these records.



WATER WELL COMPLETION REPORT

WRITE CLEARLY & PRESS HARD 1st COPY TO DRILLER, 2nd TO WELL OWNER, 3rd TO PA. GEOLOGICAL SURVEY, HARRISBURG

Well Owner ....
St. or Rd. ....
City ....
Township ....
County ....
Driller ....
License No. ....
Well Use: Domestic ....Public ....Indust. ....
Other Specify ....
Date Well Completed ....
Location Description ....

SKETCH MAP OF LOCATION

Well Depth .... ft. Depth to Bedrock .... ft.
Type Water-Bearing Rock: Gravel .... Sand .... Shale ....
Sandstone .... Limestone .... Other Specify ....
Depth to Water Bearing Zones:
First .... ft. Second .... ft. Third .... ft.
Depth to Water Before Pump Test .... ft.
Pump Test: Type of pump ....
Length of test ....Days ....Hrs. Date ....
Yield ..........G.P.M. How measured ....
When measured ....
Depth to water near end of test ....ft.
Was water level constant near end of test ......Drawdown .... ft.
Depth to water after overnight rest ....ft.
Quality Chemical Analysis: Yes ....No ....
Biological Analysis: Yes ....No ....
Condition of Water ....Temp ....°F.
Other Comments ....
Well Construction: Churn ....Rotary ....
Casing: Diam. ....Inch. Length ....ft.
2nd Casing: Diam. ....Inch. Length ....ft.
Cemented: Yes ....No ....
Screen: Length ....ft. Size slot ....

LOG OF FORMATIONS

Rock Type	Feet From - To

WW-1-65 BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY

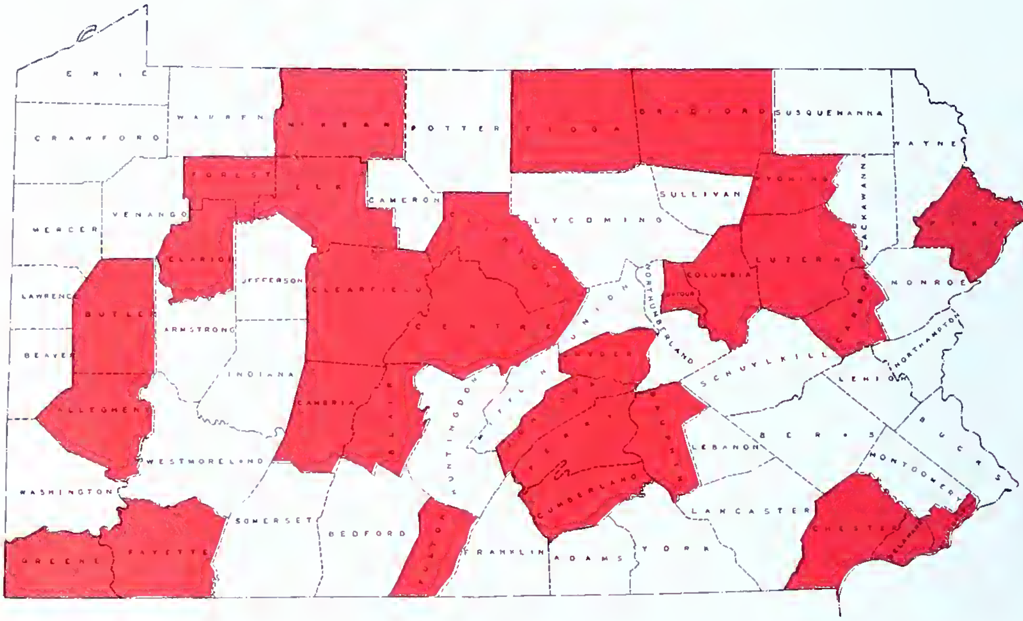
DO NOT FOLD

Well Completion Record

In order for these records, now numbering approximately 22,000 and accumulating at a rate of about 7,000 annually, to be of maximum use to all concerned with Pennsylvania's water resources, the Survey decided to transfer these data to a computer. A grant was requested from the federal department of Housing and Urban Development (HUD) to prepare them for computer storage and retrieval. Recognizing that utilization of ground-water data is a basic element in regional planning, this grant was awarded to the Survey in the spring of 1969 and work started shortly thereafter.

Two major tasks to be performed were: 1) the transferring of the information given on the well drillers completion report to coded language the computer could understand and 2) the precise location of each well on base maps and exact determination of latitude and longitude. This last task has been the biggest problem and the most time consuming. This step was necessary to make the ground-water information completely compatable with all other inventories on water being generated in conjunction with the Commonwealth's State Water Plan.

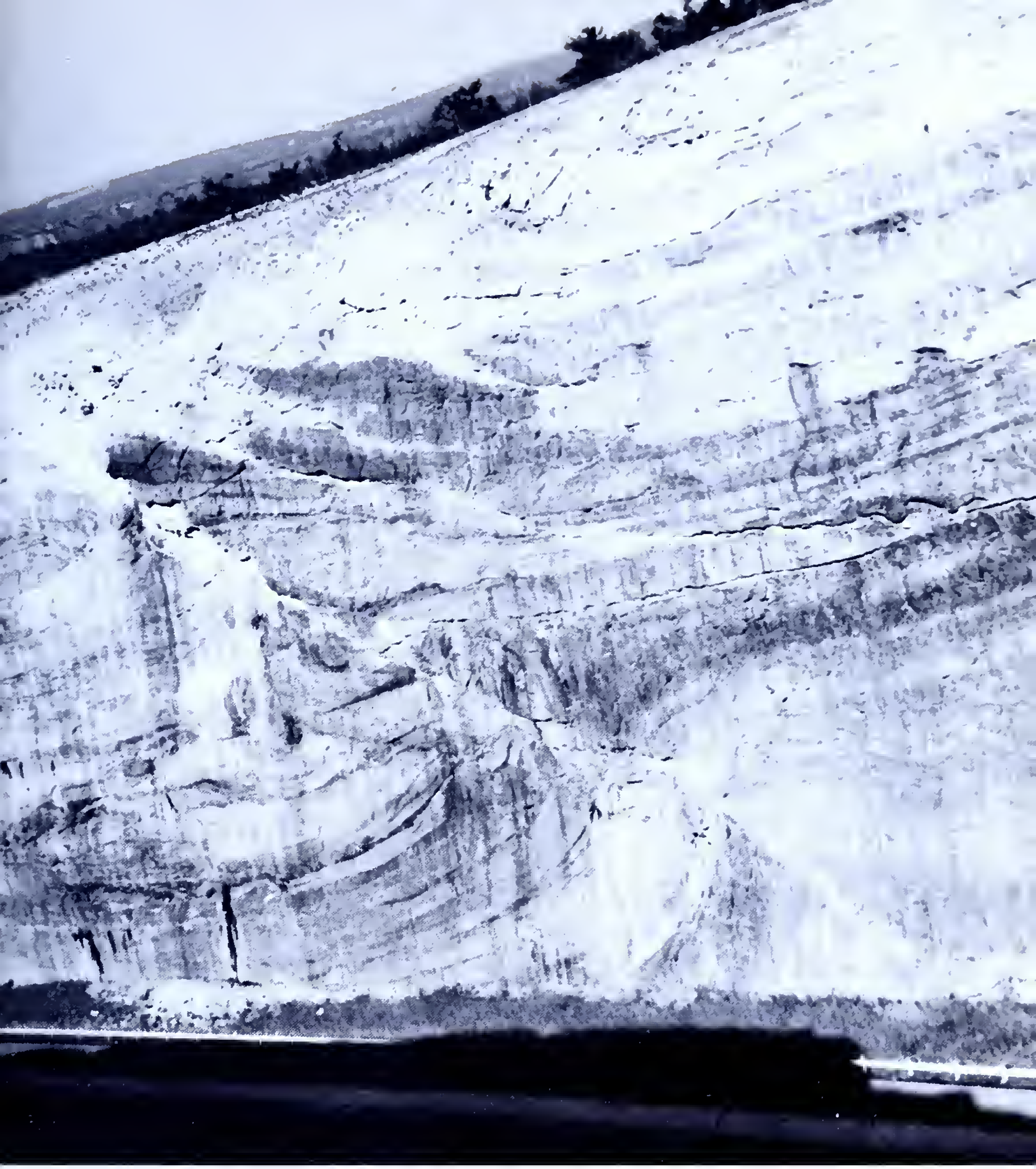
From the completed code sheet, the information is keypunched on standard computer punchcards. To date, the Geologic Survey has completed keypunching the ground-water data for the counties shown on the outline map.



Computer printout sheets are available for these counties from the Survey's Harrisburg Office. Thus, it is possible for any designated area to get an immediate printout which lists specific hydrogeologic information such as drainage basin and subbasin, topography of well site, major and minor aquifers, yield of each aquifer and zones within an aquifer, as well as a complete mechanical description of each well and quality of water data.

The Geologic Survey sincerely believes that this new approach to a comprehensive ground-water inventory will provide readily available information for all future water resource planning at both the State and local level.

Alan R. Geyer



A FAULT NEAR HAZELTON

One of the most dramatic exposures of a fault in Pennsylvania occurs in a roadcut 5 miles south of Hazelton, created during the recent construction of Interstate Route 81 in the central anthracite region. The east side of the roadcut is shown in the photo. The fault is the thin white line which slants down to the right, against which the light and dark layers (gray sandstone and conglomerate, and red siltstone, respectively) abruptly end (the vertical white lines are drill holes used in excavating the roadcut). Originally these layers were continuous and unbroken. Later, the layers were disrupted (faulted) and the rocks on the right slid up and over the rocks on the left of the fault, in much the same way as two blocks of wood can be slid past each other.

Faults are commonly single surfaces along which all the movement has taken place. However, sometimes a main fault has several smaller, branching faults, such as occur in this exposure. In the lower part of the roadcut, a small branching fault has isolated two blocks of the stripped layer from the same layers on each side of the main fault.

In many faults, the layers of rock merely break and slide along the fault plane. But in the example shown here, the layers were first bent before they broke. The direction in which the layers are bent is the same as the direction of movement on the fault. The faulting consists of two processes, bending and breaking, the bending giving way to breaking as the movement was continued, in the same way as a plastic spoon can be bent only to a certain limit before it breaks. By measuring the distance which separates identical layers, the geologist can determine that there has been about 100 feet of movement (displacement) along this fault.

Rocks vibrate when they slide on one another, just as two wooden blocks vibrate when slid over each other. On particularly large faults, such as the San Andreas fault in California, the vibrations can be heard as rumbling and the rock movements can be felt as vibration of the ground. Such noises and ground movement are known as earthquakes. On smaller faults, such as this one at Hazelton, the amount of noise is small, but can be detected by sensitive instruments called seismographs. The fault illustrated here is not active now, but developed approximately 250 million years ago when it was buried under several thousand feet of rocks which have since been weathered and carried away by streams. If seismographs had been present then, they would have recorded the movement on this fault as a minor earth tremor. This fault, then, is a permanent record of earthquake activity that occurred in the distant past.

One might well ask what caused the faulting. In order to slide a pair of wooden blocks past each other, they must be pushed. In the same manner, enormous forces were required to slide the rocks past one another. In fact, these rocks broke and faulted because the forces were stronger than the rocks, just as too much force on a pane of glass causes it to break. These enormous forces occurred throughout a large area and caused faulting in the Valley and Ridge province during a great period of folding and mountain building 250 million years ago that has resulted in the long valleys and mountains of this Appalachian region.

Rodger T. Faill
Richard B. Wells

ON STRATIGRAPHIC COMMISSION

State Geologist, Arthur A. Socolow, has been appointed to the American Commission on Stratigraphic Nomenclature, serving as the representative of the American Association of State Geologists for three years.

THE SURVEY LIBRARY HERE TO SERVE

Do you need a geological question answered about Pennsylvania or one of the other states of the Union? Are you interested in the geology of Argentina, Mexico, Great Britain or the Soviet Union? Can you read Japanese or Spanish or Roumanian? Do you need a reference on fossils, mining, or earthquakes? If so, perhaps you should visit the library of the Pennsylvania Geological Survey.

The library of the Pennsylvania Geological Survey contains over 50,000 books, periodicals, and maps. The publications of each of the other 47 state geological surveys are on hand, as we maintain a mutual exchange arrangement with them. Thus, we have available reference material for nearly every area of the United States.

Similarly, we receive publications from national geological surveys of 25 foreign countries. These include Argentina, Australia, Belgium, Brazil, Canada, Nationalist China (Formosa), Chile, Czechoslovakia, Colombia, France, Germany, Great Britain, Israel, Japan, Mexico, Nepal, The Netherlands, Poland, Portugal, Roumania, Union of South Africa, Spain, Sweden, Switzerland, and Union of Soviet Socialist Republics. So, if you plan to visit a foreign country and are interested in their geology, you may read up on the subject before you go.

The Survey library regularly receives all of the publications of United States Geological Survey and the United States Bureau of Mines. We have complete sets of each of their series of publications.

To keep up with current developments in all aspects of geology, mineral resources, and basic research, the library subscribes to over 50 periodicals, including 16 from foreign countries. In addition, eight periodical bibliographies and abstracts are regularly received to facilitate utilization of all periodical material.

Over 900 textbooks and basic reference books are on hand in the Survey's geologic library to permit comprehensive research on nearly any geologic subject.

The Pennsylvania Geological Survey library is open to anyone who wishes to use it for information or research on geology. A full-time, professional librarian is on hand to maintain the library and to assist visitors and staff in finding materials. A standard card catalogue is maintained to expedite identification and location of publications needed. This geologic library cooperates with and supplements the main State Library here in Harrisburg in handling geological reference problems.

Should anyone wish to use the Survey's geologic library, please feel free to come anytime from 8:30 a.m. to 5:00 p.m., Monday through Friday. You will be most welcome.

TANZANITE: THE NEW GEM STONE

The new gemstone, tanzanite, has been receiving a great deal of publicity. Advertisements and articles have appeared in newspapers, magazines and on television. With all this attention, you may have wondered what it is and whether or not it is rare enough, and beautiful enough, to be valuable.

Tanzanite, from Tanzania, is a new gemstone, but it is not really a new mineral. Its mineralogical name is zoisite, a member of the epidote mineral group. The name was changed to tanzanite for two reasons: (1) the gem material is blue or reddish violet whereas typical zoisite is greenish brown, and (2) the name zoisite was not deemed by gem dealers to be sufficiently enticing to prospective buyers. It has a hardness slightly less than that of amethyst, but sufficient to make it a durable gem. Its color is deep and striking when cut, varying from a deep amethyst to a sapphire blue. The blue is the more valuable color and can be produced from other colors by heat treatment. Thus, it is quite possible that some blue tanzanite offered for sale may not be the natural blue, but a synthetic blue induced by heating.

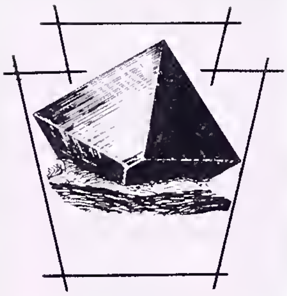
To date, tanzanite has been found only in one area of Tanzania. How much of it there is still is not known, but it seems unlikely that it will ever become a common gem mineral in the way that amethyst or garnet have. Its ultimate value will depend on the demand, the quantity that can be mined, and the rate at which tanzanite is brought before the public. Nevertheless, for those who like something new and exciting in the way of gems, tanzanite may be just what you have been looking for.

Davis M. Lapham

NEW SAMPLE LIBRARY FACILITIES

The Pennsylvania Geological Survey has recently acquired new space to house the subsurface sample library and make the facility more accessible to the many industry and research users. These valuable and irreplaceable well samples are critical in geological-engineering evaluation of subsurface reservoirs for hydrocarbon exploration and exploitation, storage and disposal, and potential brine development. In addition, increasing use is being made of data obtained from the samples in evaluation of other resources, such as salt deposits at depth, and the projection of near surface resources such as water, coal, clay, and limestone. The samples also aid in consideration of environmental geological conditions, such as groundwater pollution and unstable construction zones.

Nearly all samples have been integrated and filed in one room. These include shallow and deep well drilling samples (cable tool, rotary mud and some air drilled), and shallow and deep cored samples. The library contains samples for all or part of the geological section drilled in over 800 oil and gas wells in the Commonwealth and a few in immediately surrounding portions of other states. Adjoining space to the sample library has been set aside for sample examination. A microscope, fluorescent lamp and related material required in making sample descriptions are provided. The proximity to the samples should greatly facilitate visitor research. Those wishing to use these facilities are requested to make an appointment with the Oil and Gas Division office of the Pennsylvania Geological Survey, 401 Pittsburgh State Office Building, Pittsburgh, Pennsylvania.



EARTH SCIENCE TEACHERS' CORNER

NEW SET OF OVERHEAD TRANSPARENCIES

A set of 100 overhead transparencies is available from United Transparencies Inc., P.O. Box 888, Binghamton, N.Y. This set of transparencies was developed for the text, *Modern Earth Science* by Ramsey and Burckley, but the company states they may be used effectively with any secondary school earth science textbook. The transparencies explore relevant concepts in chemistry, biology, oceanography and meteorology. They may be purchased separately or as a set.

ENVIRONMENTAL POLLUTION

Environmental Pollution — Our World in Crisis is the title of a new filmstrip set by Ward's Natural Science Establishment. This set of six filmstrips, 414 frames in color, and a teaching guide discusses the nature of the problem, methods of coping with some aspects now, and some long range problems and possible solutions. Ward's Bulletin carried the above information in their January, 1970, issue. If you are not receiving this informative bulletin, I suggest you write Ward's and ask that your name be added to their mailing list.

1970 MARINE SCIENCE CONSORTIUM

The Marine Science Consortium of Pennsylvania Colleges and Universities will hold four 3-week sessions during the summer of 1970 at the Delaware Bay Marine Science Center in Lewes, Delaware. Within each session three undergraduate courses in oceanography are offered plus a research course for graduate credit. Interested persons should contact the Marine Science Consortium Administrative Center at Millersville State College, Millersville, Pa. 17551.

SURVEY ANNOUNCEMENTS

PENNSYLVANIA PLEISTOCENE PUBLICATIONS

Planners, highway engineers, soil scientists, water well drillers, students of glacial history and others working with the Pleistocene deposits of Pennsylvania and adjacent states will be interested in two significant Pennsylvania Geological Survey publications about surficial deposits in opposite extremes of the state.

The first is General Geology Report G 55, **Pleistocene Stratigraphy of Northwestern Pennsylvania** by G.W. White, S.M. Totten, and D.L. Gross. This report resulted from a study of numerous deep artificial outcrops created during highway construction and quarry operation during the past 10 years. The report contains 27 diagrammatic sketches of multiple drift exposures as well as extensive descriptions of the characteristics of the different aged materials. The vertical and lateral variability of glacial deposits demonstrated in this report has special significance for water supply, waste disposal and construction. The information about multiple glacial advances and retreats provides an invaluable supplement to the existing **Glacial Geology of Northwestern Pennsylvania** (General Geology Report G 32) published by the Survey in 1959.

The second publication, **Surficial Geology of the Stroudsburg Quadrangle, Pennsylvania-New Jersey** (General Geology Report G 57) by J.B. Epstein is the first comprehensive report about surficial geology in northeastern Pennsylvania. This report presents a detailed description of eight different types of glacial drift deposited during deglaciation of a single ice advance, and five different materials deposited after deglaciation. A discussion of glacial Lake Sciota and the various deposits associated with the lake provides new meaning to many of the landforms and gravel resources of the Stroudsburg area. A brightly colored geologic map and detailed laboratory analyses of several important geologic parameters such as grain size distribution, pebble lithologies and X-ray analysis of clays add to the versatility of this report.

These publications may be purchased from the Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125; G 55 is $1.00, plus sales tax; G 57 is $2.75, plus sales tax.

REPORT ON JEFFERSON COUNTY GAS POOL

Mineral Resources Report M-59, **Geology of the Elk Run Gas Pool,** is concerned with the geology and reservoir behavior of a gas pool located in Jefferson County on the southeast flank of the Sabinsville anticline. The pool is the southwesternmost of a sequence of four similar pools along this anticlinal limb. The gas is in a stratigraphic trap in the Lower Devonian Ridgeley ("Oriskany") Sandstone, between an updip porosity loss and the downdip gas-water contact. Porosity types, quality, and distribution in the sandstone, gas reserves, and analytical methods used are discussed, as well as the application of these methods and the types of data needed by those persons making similar quantitative analyses of other gas pools. The study can also be useful to those interested in problems of aquifer studies and subsurface waste disposal. Bulletin M-59 contains 18 pages, 4 figures, and 2 plates, and is available for $0.50 plus tax from the Pennsylvania Division of Documents, 10th and Market Streets, Harrisburg, Pa. 17125.

PENNSYLVANIA TRAIL OF GEOLOGY

Important geologic features in Pennsylvania are being highlighted by the Pennsylvania Geological Survey in a new park guide series - Pennsylvania's Trail of Geology. Geologic guides are being prepared for state parks and other state recreational areas that contain interesting and unusual geologic features. Each guide will outline the geology of the area in general terms and specifically emphasize any and all unique geologic features that may be seen and visited. The series will be written in an informativ style that may be read easily by the layman. Most guides will illustrate wit photographs and sketches the geologic features talked about and will include small geologic map or index map of the area.

The first three guides **Archbald State Park** (featuring the Archbald Po hole, Lackawanna County), **Hickory Run State Park** (featuring the Hickory Ru Boulder Field, Carbon County), and **Trough Creek State Park** (featuring an Ic Mine and a famous Balanced Rock, Huntingdon County) have been publishe and are available at the park office or upon request from the Survey's Harrisbur and Pittsburgh offices.

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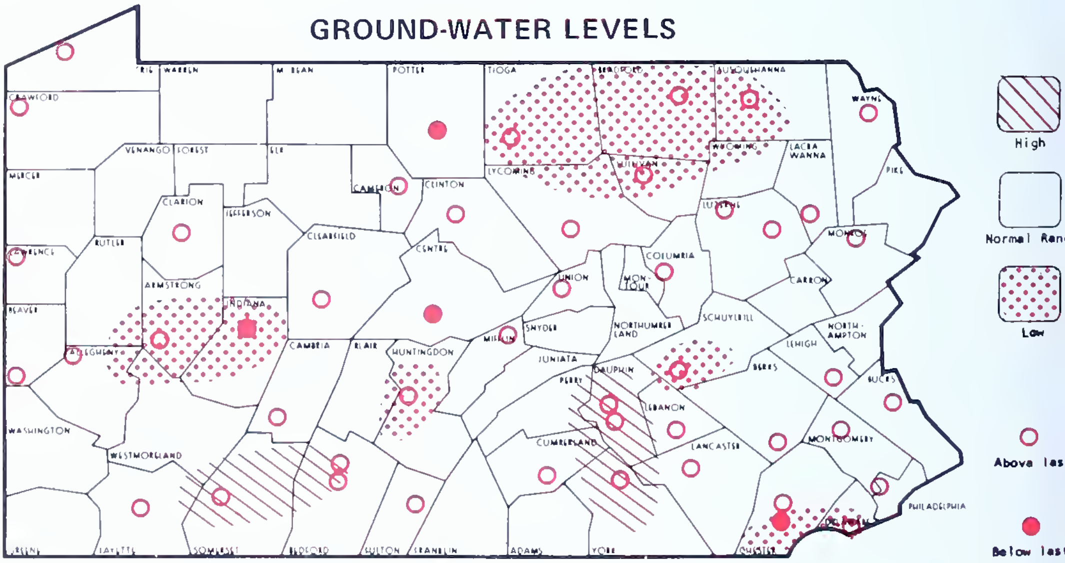
MARCH 1970

GROUND-WATER LEVELS



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GEOLOGY

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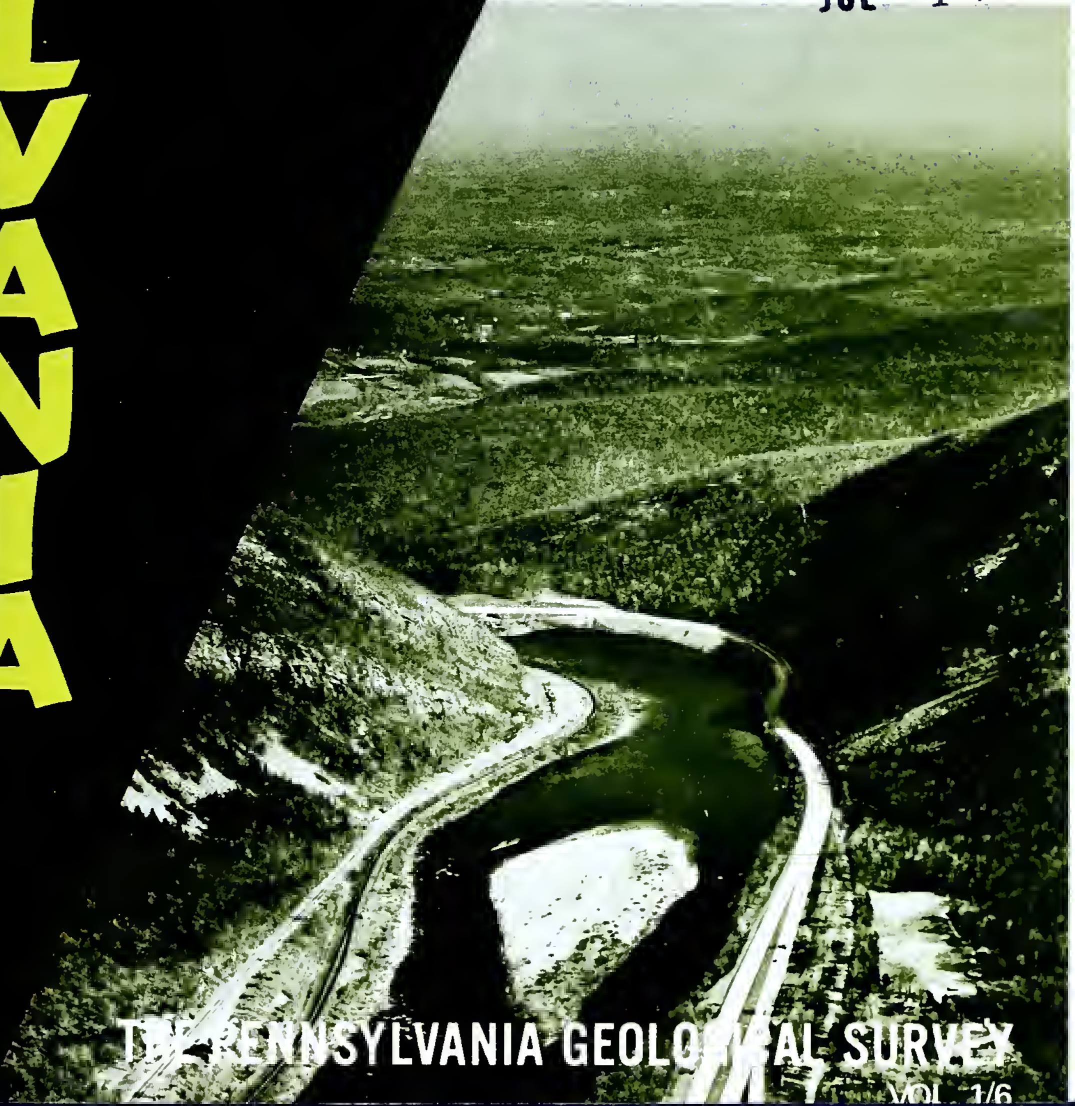


THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 1/6

COMMONWEALTH OF PENNSYLVANIA
Raymond P. Shafer, Governor

STATE PLANNING BOARD
Irving Hand, Executive Director

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

CONTENTS

The State Geologist Reports 1
The Survey's Topographic Program 2
Mastodon Bone in Bradford County 4
Big, Big Concretions 6
Pollution Effects on Buildings 8
Earth Science Teacher's Corner 10
Pennsylvania's First Mineral Industry 11
Potentially Economic Nickel in Pennsylvania 13
Survey Announcements 15

ON THE COVER — Aerial view of world-famous Delaware Water Gap. Resistant rock layers which form the ridge through which the river has cut can be seen in the walls of the gap.

Photo by Grant Heilman

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

JUNE 1970

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

EVERY DAY IS EARTH DAY FOR GEOLOGISTS

As geologists who daily carry out our responsibilities in the subject defined as "the science of the earth", we were particularly pleased that our Nation finally saw fit to observe an Earth Day. It was long overdue that recognition and consideration be extended to the small sphere which is our home, our source of life and nourishment. My concern is that Earth Day should not have been a once and only occasion, nor a once a year affair which, like Mother's Day, is so conveniently disregarded the rest of the year by so many. We sincerely hope that Earth Day 1970 will have marked the formal beginning of a great public awakening to the problems and needs of wise use and effective management of our lithosphere, our hydrosphere, and our atmosphere — better known as our land, our water, and our air.

For the most part the Earth Day meetings and pronouncements highlighted the pollution of our earth environments. Very properly it was pointed out that humanity faces calamity if the present rate of air and water pollution continue. The cleanup of some trash and litter in some neighborhoods and along some streams was lauditory. But one day's efforts could hardly have any significant effect on the results of scores of years of irresponsible despoiling of our environments; it will yet take tens of years and millions of dollars to clean up the mess. But, aside from cleaning up, a determined program must be initiated which will prevent new pollution to our environment. This will require new equipment, new procedures, new regulations, and money to pay for it all. The extra cost will not be pleasant — extra costs never are — but the importance is so great and the stakes are so high that the costs must be accepted. It is hoped that Earth Day may have helped to recognize and accept such responsibility.

Geology has an important role to play in improving and protecting our environment. It is geologic data of the subsurface which will define where in the ground it is safe and where unsafe to dispose of solid and liquid wastes. Geologic data will locate sources of quality subsurface water to augment public and industrial needs, and it will define areas where subsurface water can be augmented for storage and reuse. Most important, geologic mapping coupled with slope profile analysis will assist in defining the most effective use of each land area, its potential for resource development, for industrial utilization, for housing, agriculture, or recreation. Geologic evaluation will define hazardous conditions such as landslide and subsidence areas, as well as criteria for the most economic development of any land area.

The Pennsylvania Geological Survey, through its stress on the relevance of its geologic investigations, is pleased to be making a contribution to better environmental planning and development.

Arthur A. Socolow

THE SURVEY'S TOPOGRAPHIC PROGRAM

The Pennsylvania Topographic and Geologic Survey is the only agency in Pennsylvania which is and has been responsible for systematically developing coverage of the state with detailed topographic maps.

The organic act of the Bureau of Topographic and Geologic Survey includes the assignment that the Survey "Undertake, conduct, and maintain the organization of a thorough and extended survey of the State for the purpose of elucidating the topography of the state". The Act further delegates the Survey "To arrange for the cooperation of the United States Geological Survey to engage in such work".

The topographic mapping program in Pennsylvania is being carried out in cooperation with the United States Geological Survey. Now in the 51st consecutive year of cooperative state-federal effort, the mapping program is conducted on an equal, matching funds basis, 50-50 state and federal; the federal agency does the mapping and is reimbursed for 50% of the cost by the Pennsylvania Geological Survey and the federal agency prints the finished maps.

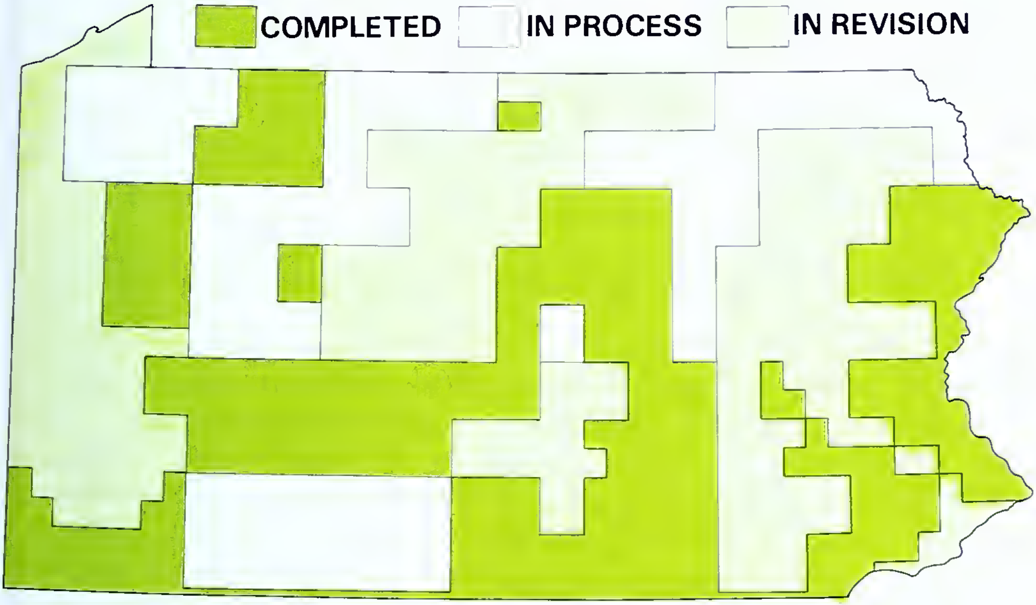
Topographic maps show the nature of the existing land forms through the use of contour lines; they also show all existing surface features including rivers, lakes, swamps, as well as all man-made features including roads, railroads, buildings, excavations, dams, and bridges. Political boundaries, including county, township, and city lines are also indicated. The maps are being constructed at the highest order of accuracy from aerial photographs with ground control, using latitude and longitude lines as margins.

It is impressive to note that Pennsylvanians and those interested in Pennsylvania's topography each year acquire some 300,000 Pennsylvania topographic maps, the highest utilization of such maps of any single state.

Topographic maps serve as a base for all planning, engineering, agricultural, industrial, and recreational projects. Wise land use, conservation, land restoration, urban redevelopment, and transportation design all require accurate topographic maps. These maps are being used at an increasing rate by all segments of our economy, including government, industry, and the private sector.

The cooperative topographic mapping program in Pennsylvania has been conducted jointly since 1919 by the Pennsylvania Topographic and Geologic Survey and the United States Geological Survey. The maps which were first produced were on a scale of an inch to the mile (1 inch on the map equals 1 mile on the ground). Each map (called a quadrangle) covered a rectangular area of 15 minutes of longitude by 15 minutes of latitude; thus, this first series of topographic maps is referred to as the 15-minute series. The progress of the 15-minute mapping program was slow, as all of the work was conducted by teams of ground surveyors who trudged from valley to ridge to valley, making all the necessary sightings and notations with awkward rod and transit instruments. The total coverage of Pennsylvania by 215 topographic maps of the 15-minute series was completed in the early 1940's.

It quickly became obvious that the early series topographic maps produced in the 1920's and earlier were badly out of date due to new roads and buildings. It was also clear that the great variety of topographic maps users needed a scale that would show more detail than the 1-inch-to-the-mile scale.



Topographic Mapping

There was initiated in 1944 a new quadrangle topographic mapping program to produce maps on a detailed scale of 1:24,000 (one inch on maps equals 24,000 inches, or 2000 feet on the ground). The new maps, showing the area in more detail than the old series, each covers a rectangular area 7½-minutes of longitude by 7½-minutes of latitude; thus, it is called the 7½-minute map series. Whereas it took 215 of the 15-minute maps to cover all of Pennsylvania, it requires 860 maps of the 7½-minute series for complete state coverage.

The 7½-minute maps are prepared much more accurately and more rapidly by the use of aerial photographic coverage of the ground area to be mapped; ground control points and field party checking of local details assures highest accuracy.

The 7½-minute series topographic mapping program proceeded as a cooperative state-federal program. By 1961, however, less than half of Pennsylvania's topographic coverage has been completed and at the pace then underway completion would come in the 1990's. There was a strong and growing demand for completing the topographic map coverage, particularly by the Highway Department which utilizes these maps for road planning and design. This resulted in a stepped-up program in 1962, aimed at completing the job within ten years.

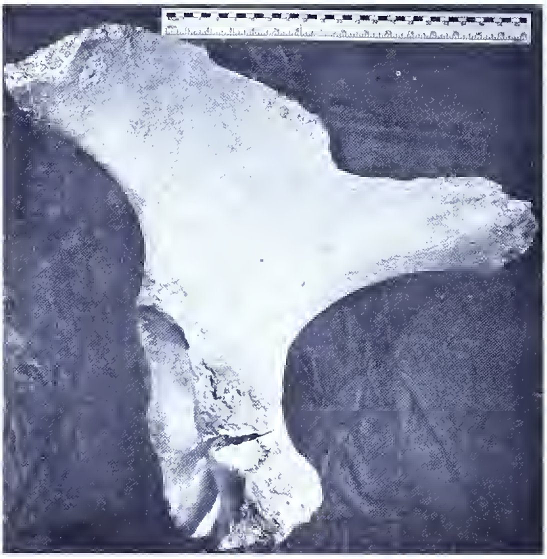
At the present time there are 684 topographic maps available for Pennsylvania, covering 80 percent of the total area. Maps for the remaining 20 percent are already well underway and at the present rate complete state coverage will be accomplished by late 1972.

But, even as the remainder of Pennsylvania's topographic map coverage is being completed, we are already revising and reprinting those topographic maps which are over ten years old. This is especially needed in those areas where population and industrial growth is responsible for a whole new network of roads, houses, schools, industrial plants, and recreation areas.

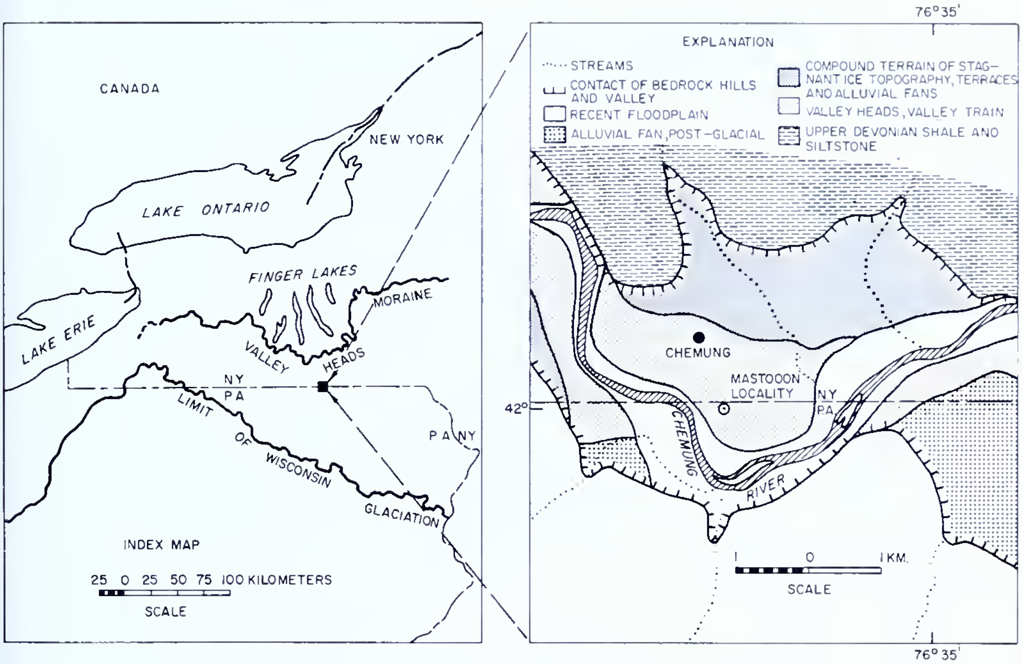
The revised, topographic maps serve not only to keep an up-to-date record of our complex landscape, but also to help plan for future growth, development and wise land use.

MASTODON BONE IN BRADFORD CO.

This story is only possible because a sharp-eyed construction worke recognized something unusual about a large bone he salvaged during the rebuilding of N.Y. Route 17. The bone was given to the State University of New York at Binghamton for analysis and has been identified as a pelvic fragment o a mastodon, *Mammut americanus,* an extinct type of elephant that roamed part of North America during the last phases of the Ice Age.



The bone, about 20 inche long, slightly friable and not mineralized, was in a good state o preservation. It was discovered in gravel pit, 11 feet below the ground in the valley of the Chemung River Bradford County, Pennsylvania 3,000 feet southeast of Chemung New York. "Chemung" is derived from an Indian name which mean "great curved bone", a reference to discoveries of tusks in the region during the 1700's. A radiometric age by the carbon 14 method indicates the mastodon died 13,32 ± 200 years ago. Although more


CANADA
NEW YORK
LAKE ONTARIO
FINGER LAKES
MORAINE
LAKE ERIE
VALLEY HEADS
NY
PA
LIMIT OF WISCONSIN GLACIATION
PA NY
INDEX MAP
25 0 25 50 75 100 KILOMETERS
SCALE
76°35'
EXPLANATION
STREAMS
CONTACT OF BEDROCK HILLS AND VALLEY
RECENT FLOODPLAIN
ALLUVIAL FAN, POST-GLACIAL
COMPOUND TERRAIN OF STAGNANT ICE TOPOGRAPHY, TERRACES AND ALLUVIAL FANS
VALLEY HEADS, VALLEY TRAIN
UPPER DEVONIAN SHALE AND SILTSTONE
CHEMUNG
MASTODON LOCALITY
NY
PA
42°
CHEMUNG RIVER
1 0 1 KM.
SCALE
76°35'

LOCATION OF MASTODON LOCALITY

than 40 other mastodon sites have been dated in eastern North America, only the one in Sumter County, Alabama, is older.

Perhaps the greatest significance of the bone is its geologic occurrence, and this coupled with the date provide important new insight of glacial events in the region. Investigation of the terrain and the gravel characteristics reveal the bone was deposited by meltwaters from the Valley Heads ice sheet when the ice front stood several miles north of the site. Prior to this discovery the actual age of the Valley Heads deposits was unknown. Thus the glacial maximum of this last ice sheet in the region could not have occurred much more than 13,000 years ago.

Donald R. Coates
State University New York,
Binghamton, New York 13901

WOW! WHAT AN EXPRESS BILL

The Survey tries it's darndest to accommodate all requests. The following one which came through the mail may be a little complicated:

Dear Sir:

Please send me the Bureau of Topographic and Geologic Survey.

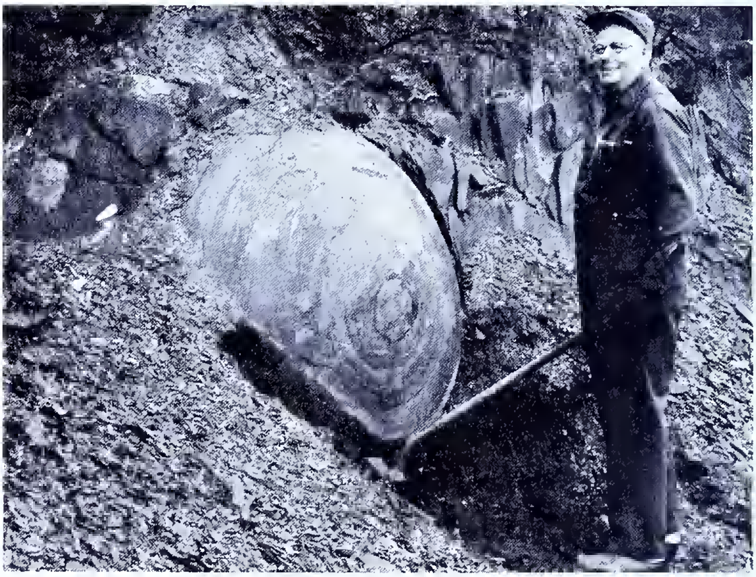
Thank you,

---- ------

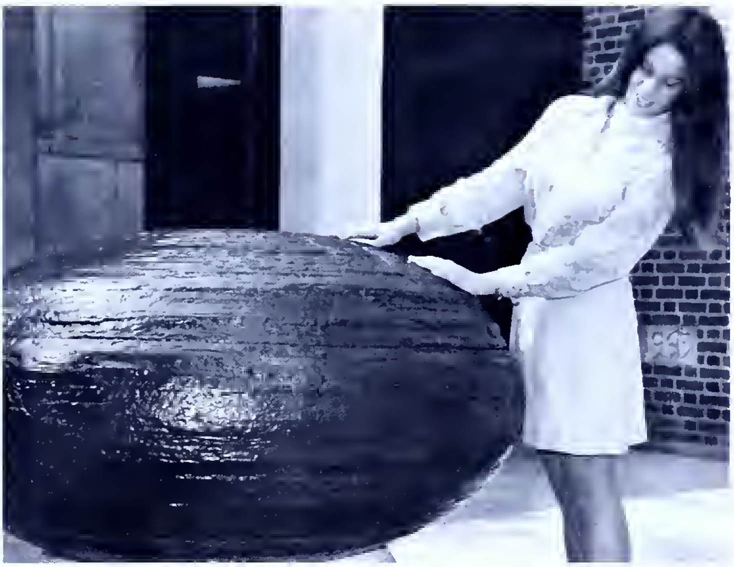
BIG, BIG CONCRETIONS

In their description of the Burket member of the Harrell shale in th Bellefonte Quadrangle, Butts and Moore indicated that “in some places there ar large calcareous concretions as much as 12 to 20 inches in diameter”. Occasiona finds of the concretions falling within that size range were brought to th writer's attention near Port Matilda in Centre County. The largest concretion were brought to the writer's attention about 1962, when 17 miles to th southwest along the outcrop of the Burket member of the Harrell shale, abou two miles south of Tyrone, at Graziersville, in Blair County, a bulldoze unearthed several on the order of 2½ to 4 feet in diameter, near Route 22 Others found or exposed in cuts ranged in size from about six inches to abou eight feet in diameter (see photo).

Besides the large size, there are several interesting aspects about the concretion occurrence: Among them are: (1) the relative abundance of those in th four foot diameter range, (2) the perfection or roundness as opposed t irregularly-shaped masses, and (3) the relatively clean parting which exist between the concretion and the enclosing shale. The writer wishes to sugges that the sharp parting is due to the fact that the shale in this location has nearly vertical dip, allowing meteoric water to percolate freely downward alon the shale layers, causing solution at the shale-concretion interface. This situatio contrasts markedly with those concretions often found in the black shales of th anthracite and bituminous coal fields in Pennsylvania in which there is no shar transition between the concretion itself and the enclosing shale.



Maynard Williams at excavation near Grazierville.



Debbie Danko views concretion at College of Earth and Mineral Sciences

Concretions commonly form in unconsolidated sediments because of an abundance of some material, usually calcium carbonate in solution. Chemical precipitation takes place around a nucleus, often a fossil, and the concretion increases in size by successive additions of material to its surface. During this process the original sediment is usually displaced by the enlarging concretion, although it can sometimes incorporate up to about 60% of the enclosing sediment in silt or sand. Little is found in the way of fossil material at the Grazierville site except for occasional calcite or pyrite crystal lined cavities which suggest a fossil may once have occupied the void. Needless to say, there is some inherent difficulty in chopping up a four-foot concretion to find the remains of a fossil in its center.

When a concretion forms in sediments having nearly isotropic qualities with regard to movement of solution, it is likely to be spherical. When forming in an anisotropic media, such as clay or mud where mobility of solutions are greatly restricted in the vertical direction, the results are flattened shapes. In the case of the "Tyrone Concretions" they are often oblate spheroids of rather remarkable perfection, which becomes particularly impressive when their large size is taken into consideration.

Selected Reference: Butts, Charles and Moore, Elwood S., Geology and Mineral Resources of the Bellefonte Quadrangle, Pennsylvania, U.S. Geological Survey Bull. 855. (Out of print)

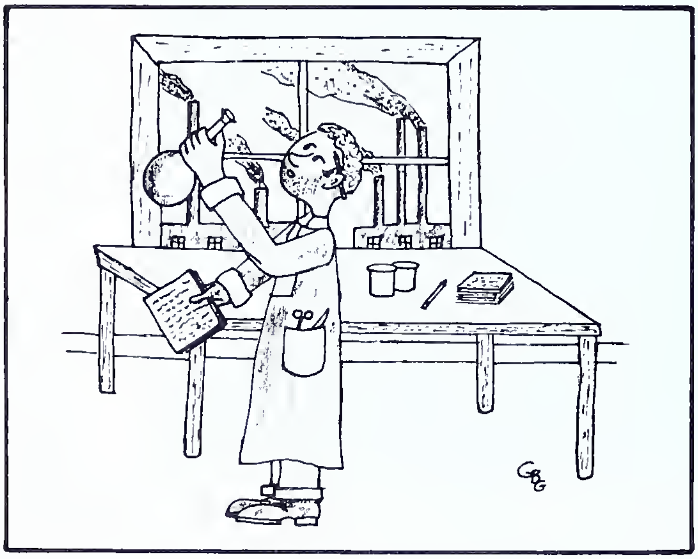
David E. Snell
Earth & Mineral Sciences Museum
The Pennsylvania State University

POLLUTION EFFECTS ON BUILDINGS

We are all rapidly becoming familiar with the effects of air and water pollution on human, animal, and plant life. As our environment of climate is changed, so is the quality of life altered for all living organisms.

Another less well-known effect of pollutants, is their harmful effect on stone and cement building materials. Most pollutants, for example, carbon dioxide and sulphur dioxide, can dissolve in rain or fog. The result is the formation of a weak acid in the air. Over a period of time, depending on their concentration, these acids eat away at the stone, concrete, and even metal foundations of buildings. They can also speed up the rate of land erosion which is itself a major ecological problem.

Besides dissolving out material, some pollutants actually react with certain kinds of rock used in building materials, eventually causing dangerous weakening. Marble, limestone, and dolomite are particularly susceptible to corrosion by sulphates. Sulphur from the air combines with the calcium in these rocks to form gypsum which is 32 times more soluble than limestone. It is easily dissolved away by rain water. If in a dry climate so that gypsum remains behind, the situation is even more serious. The gypsum can take on, or lose, water. In so doing, it changes volume and this reaction can occur merely as a result of humidity changes. The resultant shrinking and swelling exerts high pressures on the pores and cracks of limestone or marble, eventually causing cracking and severe weakening of the stone in the buildings. In this regard, dolomite is even worse than limestone or marble because it contains magnesium. The formation of magnesium sulphate by contact with sulphur-containing air and by contact with water pollutants can result in even greater shrinking and swelling. There are many more types of hydrated magnesium sulphate than of calcium sulphate.



"Just a little more pollution and I can recommend this air as economically mineable."

Some pollutants, however, are not this harmful. In fact, particles of dust in the air will combine with the sulphate, falling to earth as particles of gypsum. This helps to reduce the danger to building stone materials. Unfortunately, the greatest amount of dust in the air occurs during dry seasons, and it is during the wet seasons that pollutants are dissoved by moisture and will create the most dangerous acid conditions.

Although the pollution effects on building materials may not be as critically serious as the effects on life, they can be significant. Loss of property, or even lives may result from structural failure of buildings. In addition, the beauty of architectural design and outdoor sculptures can be seriously defaced.

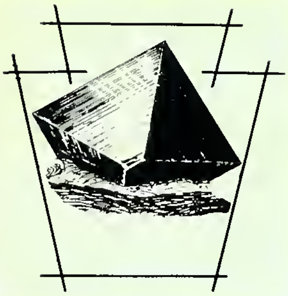
Pollutants truly are a multi-directed menace. Proper understanding and use of geological materials can help in this important cause.

D.M. Lapham

FORMATION OF DEWEYLITE BENEFICIAL TO CEMENT

In many areas, Portland cement is made from dolomite limestone. Such a source rock results in a high-magnesia cement. When the amount of magnesia exceeds 5 percent, the product tends to expand and crack. The cracking occurs because the magnesia hydrates to the mineral brucite with a resultant increase in volume. A solution to this problem has been found by combining the water involved in hydration to form a silicate mineral that does not expand the cement. The silicate "mineral" formed is called deweylite, which actually is a mixture of two minerals, serpentine and probably talc.

Deweylite occurs as a natural mineral in Pennsylvania, particularly in the serpentine-rich rocks of Lancaster and Chester Counties. A study of Pennsylvania deweylite was made by D.M. Lapham, Pennsylvania Geological Survey, in 1961. Based upon this study and upon samples supplied by the Survey from Pennsylvania, the British team of Speakman and Majumdar at the Building Research Station, Garston, England has found that adding pulverized fly-ash to high-magnesia cement results in the formation of deweylite, rather than the more harmful brucite. The results of this team of British workers will be published late this year and should prove to be of great value to the cement industry. The Pennsylvania Geological Survey is glad to have contributed basic mineralogical information that helped in understanding and solving this important industrial problem.



EARTH SCIENCE TEACHERS' CORNER

U. S. GEOLOGICAL SURVEY'S LEAFLET SERIES

Several new U.S.G.S. leaflets have been added to this popular geolog series. The emphasis appears to be on water with the release of six pamphlets o this subject:

"Reports on Public Water Supplies of the United States", 5 p.
"U.S. Geological Survey Publications on Floods", 19 p.
"The Hydrologic Cycle", 5 p.
"Water of the World", 19 p.
"Water Conservation", 5 p.
"The Northeast Water Supply Crisis of the 1960's", 15 p.

One additional leaflet, **"Volcanoes of the United States"**, is available an should prove to be a valuable addition to the teachers single topic referenc material.

ENVIRONMENTAL EDUCATION FOR EVERYONE

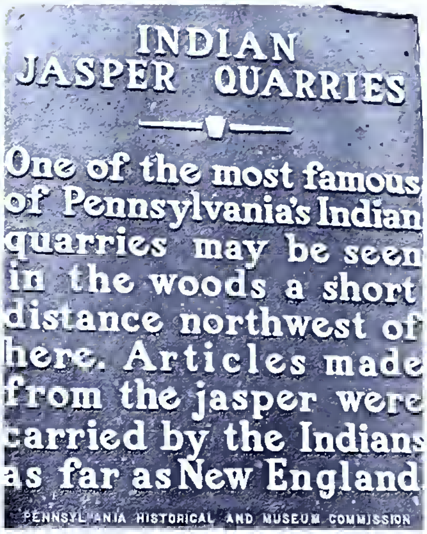
A bibliography of current material for environmental studies calle **"Environmental Education for Everyone"** is being offered by the Nation Science Teachers Association. The price of the 36-page bibliography is $0.75 p copy and payment must accompany the order. Send all requests to the Nation Science Teachers Association, 1201 16th Street N. W., Washington, D.C., 2003

HELPING PENN STATE CONSERVATION WORKSHOP

For the eleventh consecutive year, State Geologist Arthur Socolow w help conduct the annual Conservation Education Workshop scheduled at T Pennsylvania State University, July 13, 1970. The workshop is conducted by t College of Education and each year attracts 40 to 60 elementary and seconda teachers and administrators. Taking the course as an elective, the educators ha a sincere interest in learning practical aspects of conservation in the vario natural sciences.

Dr. Socolow will again lead discussions and field trips on principles a practices of mineral and land surface conservation.

PENNSYLVANIA'S FIRST MINERAL INDUSTRY


INDIAN
JASPER QUARRIES
One of the most famous of Pennsylvania's Indian quarries may be seen in the woods a short distance northwest of here. Articles made from the jasper were carried by the Indians as far as New England
PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION

It may be that Pennsylvania's giant mineral industry started near the small community of Vera Cruz in Lehigh County. High-quality jasper was discovered here by the Delaware Indians, long before the early settler arrived on the scene. At the height of their activity, more than 100 small pits or quarries were operated. The light-brown colored jasper they quarried found its way up and down the eastern seaboard, from New England to Georgia.

Jasper is a variety of quartz that is fine-grained, nearly opaque, and contains hematite or limonite that gives it the characteristic red or yellow colors. The color of most of the Vera Cruz material ranges from yellow-brown to reddish brown. There are lesser quantities of dark red, reddish black, and yellow-gray jasper. Very rarely, the deep red material is clear or translucent in thin fragments. This material is called carnelian. Jasper that contains small veins of white chalcedony is called agate-jasper. It occurs here sparingly. Except for mottling ("mossy jasper") and fracturing, the material is quite homogeneous and hence excellent for Indian weaponry. Along some of the fractures there are drusy (very small) quartz crystals and rarely some thin bands of carnelian. Some of the jasper is composed of fragments such that the rock can be called a jasper breccia. This material is not suitable for arrow or spear points because it will not chip to a smooth, curved surface. Similarly, material with many small fractures probably was discarded by the Indian quarrymen.

Some of the larger quarries, worked by hand and crude tools, extended about 40 feet in depth and probably 100 feet in diameter. The Indian quarrymen are thought to have used pick axes of deer antlers, like the ancient flintworkers of Europe, as well as poles of various sizes, charred and sharpened in order to scratch the ground and pry up the boulders. Quartzite implements found in these pits were undoubtedly used as digging tools. Field evidence shows that the Indian found much of the jasper occurring as nodules and boulders in a soft yellow clay. After he rolled away the surface boulders, those lying deeper were pried up one by one with sharpened poles and the surrounding clay scraped away until the pits were made. From the scattered fragments of charcoal found in these shafts, it may be that the Indians heated the large chunks of rock in

order to fire-fracture them. This would enable him to get rid of the worthless, bulk material as well as find the better-quality interior portions of some boulders.

Fairly large blocks of quality jasper were lifted to the surface; there to be trimmed into "blanks" for arrow and spear points. The quarry site became the mining camp and not the location of the village. The jasper "blanks" were carried to their settlements along the rivers of eastern Pennsylvania where they could be chipped into finished points by skilled craftsmen of the tribe.

Mr. H. C. Mercer in his article titled, *Indian Jasper Mines in the Lehigh Hills,* 1894, (reprinted in Pennsylvania Survey's Bulletin C-39, "Geology and Geography of Lehigh County), places the abandonment of work in the Vera Cruz quarries at about 1680 to 1690. In relationship to the early settlers in Lehigh County, we are told that white traders came to the Lehigh Valley as early as 1701 to trade with the Indians, but it was considerably later, about 1715, that any permanent settlers arrived.

Today, many of these quarries have been destroyed by man's quest for space, but the community of Vera Cruz, realizing that this important cultural and mineral heritage should be saved, has built a public park, aptly named "Jasper Park", around the larger pits.

Alan R. Geyer
Davis M. Lapham

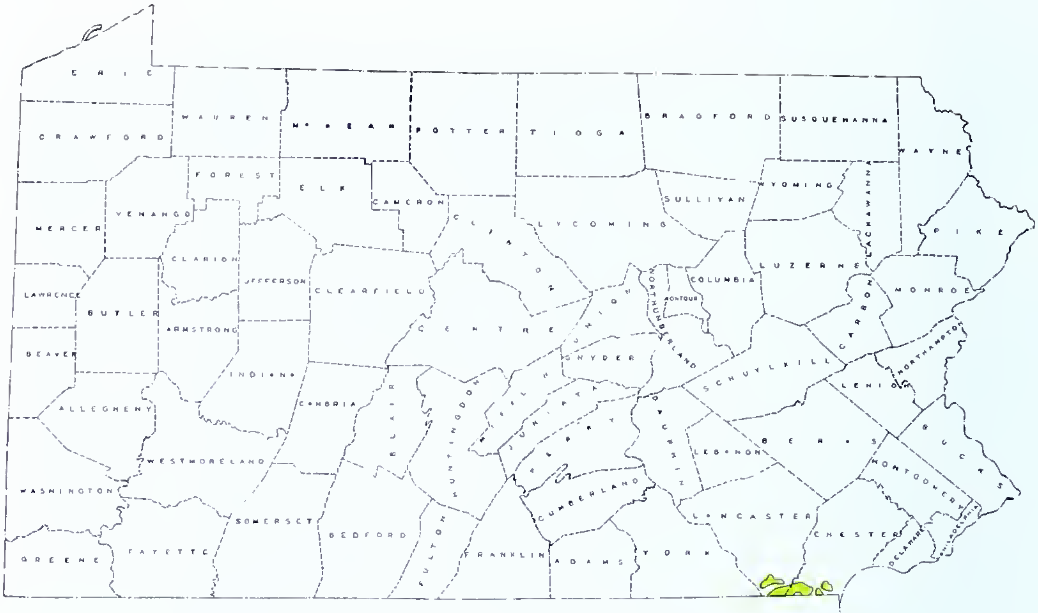
POTENTIALLY ECONOMIC NICKEL IN PENNSYLVANIA

Since the closing many years ago of the Gap nickel mine near Gap, Lancaster County, nickel has not been mined in Pennsylvania except as a by-product of the magnetite-ore mining industry. The ore body at Gap was small and the volume of rock in which the nickel occurs also is small. However, nickel is a metal that is in great demand, especially since the United States is a major importer of nickel, much of it coming from Canada.

Recent work on Canadian nickel deposits by H. A. Chamberlain for the Geological Survey of Canada has revealed certain exploration criteria that can be applied in Pennsylvania. In assessing Canada's future potential for nickel, Dr. Chamberlain believes that rocks containing at least 0.20% nickel are of interest. Current mining cut-off limits are about three times this amount, or about 0.60% nickel. This is the first limiting criterion in assessing the nickel potential of any rock. In southern Lancaster and Chester Counties, Pennsylvania, there is one rock type that meets this initial test and hence is worthy of serious investigation. It is an igneous rock of the ultramafic type. Its specific name is serpentinite, resulting from the fact that the mineral serpentine composes most of the rock. Other minerals present include olivine, talc, chlorite, tremolite, magnetite, chromite, magnesite, brucite, and pyrite.

Analyses of serpentinite by H. L. McKague showed amounts of nickel ranging between 0.06% and 0.97%; the latter high value occurring at Cedar Hill in southern Lancaster County. Most of his analyses range between 0.2% and 0.4% Ni. Four recent analyses of serpentinite from west of New Texas (west of Cedar Hill), Lancaster County, by D. M. Lapham for the Pennsylvania Geological Survey show the following nickel contents: 0.40%, 0.41% 0.48% and 0.58%. Thus, it is clear that most analyses of Pennsylvania serpentinite lie above the 0.20% cut-off limit of Chamberlain, and some lie above the present ore-grade cut-off limit of 0.60%. To date, the distribution and the average content of the nickel in serpentinite have not been studied in comprehensive detail, but such a study merits serious consideration for our future needs.

Dr. Chamberlain lists other criteria that will be useful in any future exploration in Pennsylvania. The first is the presence of other sulfide minerals with an over-all nickel:copper ratio greater than one. Some sulfides are present in the Pennsylvania serpentinites and one analysis of the nickel:copper ratio by D. M. Lapham is about 4:1. More data on copper as well as nickel are needed. His second criterion is even more interesting in the light of the presence of pyrite in these rocks: pyrite is an even more favorable indication of a potentially high nickel content than other sulfide minerals. Thus, pyrite distribution also is very important. A third criterion concerns the alteration of sulfide minerals during the formation of serpentine and a fourth the formation of native metals that, as yet, have not been identified in the ultramafic rocks of Pennsylvania. Dr.



Location of Nickel-Bearing Serpentinite

Chamberlain's final criterion is that ultramafic rocks in contact with any sulfide-rich rocks adjacent to the ultramafic are target areas for study. Analyses by D. M. Lapham of these surrounding country rocks show that sulfur ranges from 0.003% to at least 0.04%, and probably to much greater concentrations. Although the present sulfur information is scanty and although the distribution of sulfur in these country rocks appears to be irregular the highest sulfur contents found to date are in south-central and southwestern Lancaster County. Here pyrite cubes and limonite pseudomorphs after pyrite are moderately common.

In the light of the high nickel content, a nickel:copper ratio greater than one, and the presence of pyrite in the serpentinites of Lancaster and Chester Counties, future research and exploration here may reveal a good potential for nickel mining on a large scale when, and if, lower concentrations of nickel become economically profitable. In fact, present information does not rule out the possibility of a rather concentrated nickel deposit existing somewhere at depth. Now the task is to find the exact distribution both across the surface and at depth below the surface of nickel, copper, and sulfur. When this is done, the nickel potential of these rocks will be well defined and the economics of our future in this area more securely known. The Pennsylvania Geological Survey is pleased that we have been able to take an initial step in this important direction of delineating our future growth.

References Cited:

Chamberlain, J. A. (1968), Some geochemical factors in nickel exploration, in "Guides To Prospecting", Canadian Mining Journal, May, p. 49-57.

McKague, H. L. (1964). The geology, mineralogy, petrology, and geochemistry of the State Line Serpentinite and associated chromite deposits, Ph.D. thesis, The Pennsylvania State University.

D. M. Lapham

SURVEY ANNOUNCEMENTS

PUBLICATION ON MINERAL INDUSTRIES & CONSERVATION

A new publication, "Proceedings: Fifth Forum on Geology of Industrial Minerals" has been released by the Pennsylvania Geological Survey. This volume contains the papers and panel discussion presented at the May 1969 Industrial Minerals Forum which was hosted in Harrisburg by the Pennsylvania Geological Survey.

The publication is divided into three sections covering the following themes: Geology of Sand and Gravel Deposits; Relation of Industrial Mineral Production to Urbanization and Conservation; Symposium on Industrial Minerals, Land Use, and Conservation. The volume includes 14 papers by outstanding geologists, and a panel discussion by experts from academic, industrial, and conservation agencies involved in applied and research activities. The papers and discussions stress the role of science and technology in solving the problems we face in providing an adequate supply of industrial minerals for our present and future needs.

Bulletin M 64, "Proceedings: Fifth Forum on Geology of Industrial Minerals", edited by K. V. Hoover, should be of interest and use to geologists, planners, lawyers, mineral producers, and all interested in conservation and wise land use. The publication is illustrated with charts, maps, and photos. This report may be obtained from the Bureau of Publications, P.O. Box 1365, Harrisburg, Pa. 17125 at $2.35 plus $.15 sales tax for Pennsylvania residents; checks should be made payable to "Commonwealth of Pennsylvania".

EXPERIMENTAL MINE DRAINAGE TREATMENT PLANT

A neutralization plant capable of handling 500,000 gallons per day of acid mine water has recently been completed at Hollywood in Clearfield County, Pennsylvania. The plant was designed and will be operated by the Mineral Preparation Department of The Pennsylvania State University. The project is cosponsored by the Coal Research Board of the Pennsylvania Department of Mines and Mineral Industries and the Federal Water Pollution Control Administration of the U.S. Department of the Interior.

The plant site was selected to provide four different water sources fo treatment. These sources include large variations in type and level of contaminants. For this reason, the plant has been designed to treat water with a pH ranging from 2.60-4.30 and acidity (in ppm $CaCO_3$) varying from 39-8100, a well as wide variations (in ppm) of iron, aluminum and sulfate. The plant operation will produce a water which will meet current Pennsylvania requirements fo industrial wastes, including a pH in the range between 6 and 9, no titratabl acidity, and an iron content less than 7 milligrams per liter.

The plant will provide special capability for studying solid-fluid separatio and disposal of the sludge that is developed during the neutralization process This sludge has a high moisture content for which no practical use has bee developed. If treatment of these acid mine waters becomes commonplace, as i anticipated in Pennsylvania, attention will have to be given to satisfactor disposal of the sludge.

SINKHOLE IN CROSS SECTION

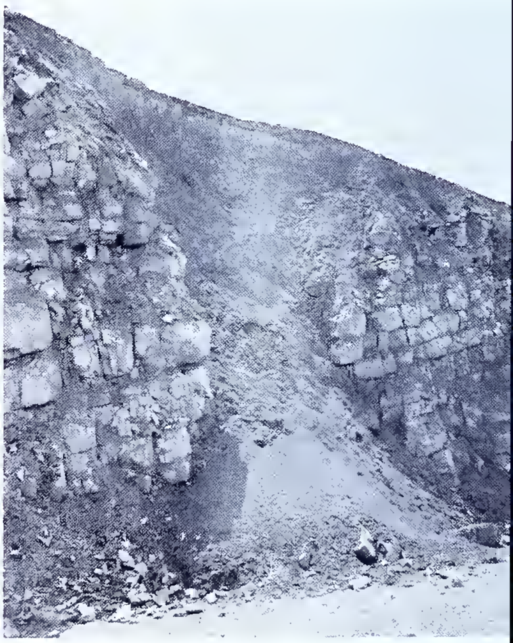
In "limestone" areas throughout Pennsylvania, sinkholes are more or les common features of the land surface. This is true because carbonate rocks consisting of limestone and dolomite, are susceptible to solution and thu gradual dissolving of the rock by water seeping through it. Sinkholes are the formed by the collapse of the surface materials into a solution cavity in the rock

But have you ever seen an actual cross section of a sinkhole?

I would guess that the opportunity to view one in cross section is certainl rare. This is now possible for the person who is traveling west on Interstat Route 80 between the Mackeyville and Lamar Interchanges in central Pennsylvania.

Approximately midway between these two interchanges, on the south side of the road, are two large sinkholes which have been cross-sectioned when the roadway was built.

The medium-light-gray dolomite exposed here is thick-bedded and probably is part of the Bellefonte Formation of central Pennsylvania. The accompanying photograph is of the westernmost sinkhole of the pair present in the roadcut.



William H. Bolles
Pa. Dept. Education

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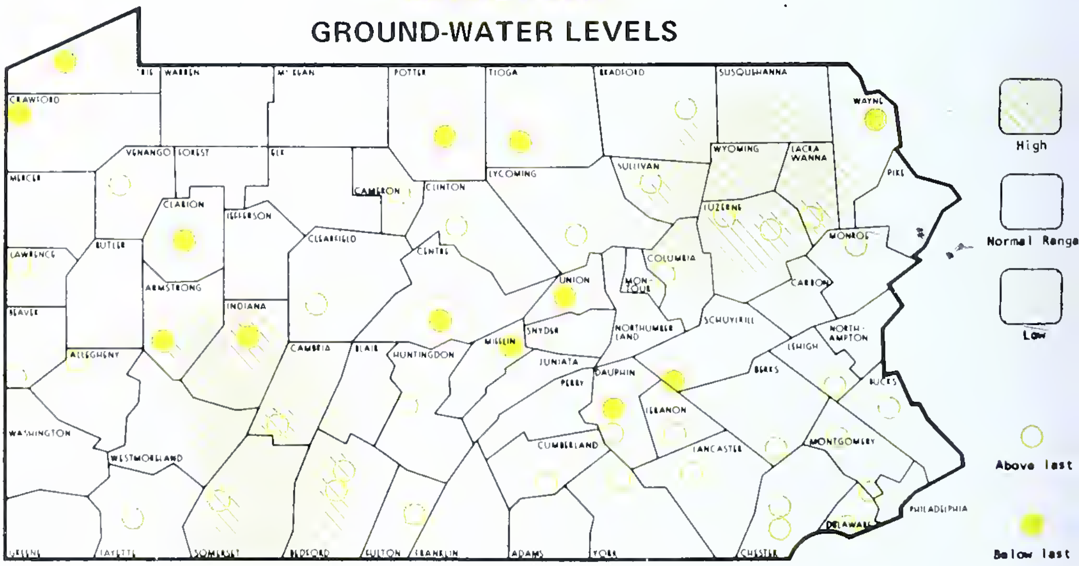

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CONTENTS

The State Geologist Reports 1
Geological Research in Pennsylvania 2
Research in Progress 2
Publications, 1969 - April, 1970 22
Survey Announcements 29
Annual Field Conference 32

ON THE COVER — New X-ray fluorescence and recording instruments enable the Pennsylvania Geological Survey to expand its mineralogical research program.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

AUGUST 1970

FROM THE DESK OF THE STATE GEOLOGIST . . .

GEOLOGIC RESEARCH A NEED FOR RELEVANCE

Recognizing that most readers of Pennsylvania Geology have an interest in keeping up with geologic research in Pennsylvania, this issue of the bulletin is devoted to a comprehensive enumeration of all such research brought to our attention. It is pleasing to note that Pennsylvania's varied and complex geology continues to attract new research efforts not only by researchers from in-state institutions, but also by researchers far beyond our borders. We are also happy to see that so many of the current research efforts are field projects directed toward resolving field and regional geologic problems. In an era when the pendulum has swung so far to the side of laboratory research, it is good to see that so many recognize that there are still challenging and inspiring problems to work on in the field.

The time is now ripe for our geologic researchers to carry their efforts that one giant step farther which will relate their sophisticated research efforts and findings to man and his environment. Research geology and environmental geology need not be separate and incompatible, as some of our traditionalist colleagues contend. Environmental geology need not be non-scientific, even as research need not be limited to enumeration of principles and processes.

As members of society with unique capabilities, geologists have a responsibility to aid man to manage and protect his physical environment. It will not do for geologists to be aloof and disdainful of man's needs, for in that case men of lesser abilities will fill the void. Each geologist should now assess the relevance of his contributions. The Pennsylvania Geological Survey is acutely aware of geology's impact upon man in Pennsylvania. Thus, we encourage and support geologic research that has a relevance to the needs of man.

Arthur A. Socolow

GEOLOGICAL RESEARCH IN PENNSYLVANIA

1970

INTRODUCTION

The fourteenth annual report of Geological Research in Pennsylvania has been compiled by the Pennsylvania Geological Survey as a service to all individuals interested in geological research on Pennsylvania.

The listings are grouped into major categories of research to facilitate your search for information on a particular subject. Project descriptions are printed where authors supplied us with such descriptions. Publications printed during 1969 and the first part of 1970 are listed alphabetically.

As with all compilations, there may have been omissions. If you know of anyone who would be interested in receiving this annual report, send us their name so that it can be included on our mailing list. Additional copies can be obtained by writing to the Bureau of Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pa. 17120.

RESEARCH IN PROGRESS

AREAL GEOLOGY

HAROLD H. ARNDT, U. S. Geological Survey. Western Middle Anthracite Field, Pennsylvania.

KENT BUSHNELL, Slippery Rock State College. Geology of Ohiopyle State Park.

KENT BUSHNELL, Slippery Rock State College. Geology of McConnells Mill State Park.

AVERY A. DRAKE, JR., U. S. Geological Survey. Geology of Allentown Quadrangle. Objectives: To decipher the tectonic history of the area with special emphasis on the emplacement of gravity slides, Alpine nappes, and thrust sheets.

JACK B. EPSTEIN, U. S. Geological Survey. Geology and Mineral Resources of the Wind Gap and Adjacent Quadrangles.

RODGER T. FAILL and RICHARD B. WELLS, Pennsylvania Geological Survey. Geology and Mineral Resources of the Millerstown 15-Minute Quadrangle. Areal mapping, stratigraphic description, and structural analysis of the geology in the Millerstown 15-minute quadrangle with discussion of economic resources, engineering properties of the rocks, and ground water potential.

DONALD W. FISHER, New York Geological Survey. Geologic Map of New York - 1970. Five sheets (scale 1:250,000); also generalized tectonic-metamorphic map (approx. 1:1,500,000) with master legend and references on 6th sheet.

GARY B. GLASS, Pennsylvania Geological Survey. Geology and Mineral Resources of the Houtzdale and Ramey 7½-Minute Quadrangles.

ALBERT D. GLOVER and THOMAS M. BERG, Pennsylvania Geological Survey. Geology and Mineral Resources of the Northern Half of the Penfield 15-Minute Quadrangle.

DONALD M. HOSKINS, Pennsylvania Geological Survey. Geology and Mineral Resources of the Millersburg Quadrangle.

DAVIS M. LAPHAM, Pennsylvania Geological Survey. The Serpentinites and Associated Rocks of Lancaster County, Pennsylvania. Structure, lithology, petrology, mineralogy, geochemistry, and economic geology of the serpentinites and associated metasediments of Southern Lancaster County.

RICHARD NICKELSEN, Bucknell University. Cleavage in Bloomsburg Formation in Buffalo Valley.

JOHN O. OSGOOD, Lehigh University. A Paleoenvironmental Study of the Allentown Formation. A stratigraphic and petrographic examination of the Allentown Formation in the area of its outcrop between the Delaware and Schuylkill Rivers is to be conducted in order to determine the environment of deposition, nature of the Allentown paleoslope and its relationship to the Reading Prong.

JOHN B. ROEN, U. S. Geological Survey. Geology of the Midway Quadrangle, Southwest Pennsylvania.

JOHN B. ROEN, U. S. Geological Survey. Geology of the Waynesburg-Oak Forest Area, Southwest Pennsylvania.

S. P. SCHWEINFURTH, U. S. Geological Survey. Geology and Mineral Resources of the Claysville-Avella Area. This project is to geologically map two 7½-minute quadrangles and parts of two others that join them on the west to complete geologic mapping to the Pennsylvania State Line in Washington County; to evaluate coal and other mineral resources and to gather and evaluate data that will aid in understanding the depositional framework of the Upper Pennsylvanian-Lower Permian of the northern part of the Dunkard Basin, its structural history, and the paleogeographic controls of coal accumulation and quality.

WILLIAM D. SEVON, Pennsylvania Geological Survey. Geology and Mineral Resources of the Northern Half of the Lehighton 15-Minute Quadrangle, Pennsylvania. Mapping and detailed interpretation of the geology of the area.

WALLACE de WITT, JR., U. S. Geological Survey. Hyndman 15-Minute Quadrangle. Field work this year will be concentrated mainly in the southwest part of the area in the valley of Wills Creek, south of the town of Hyndman and along the Allegheny Front to west of Wills Creek.

GORDON H. WOOD, JR., U. S. Geological Survey. Drainage of Anthracite Mines Southern Anthracite Field. A comprehensive study of the geology of the southern and eastern parts of the Pennsylvania Anthracite region. Project aims for an understanding of Silurian through Pennsylvanian rocks, the tectonics of the Appalachian Plateau and Valley and Ridge Provinces in eastern Pennsylvania, and the causes, whether sedimentary or structural, that resulted in the formation of anthracite.

ECONOMIC GEOLOGY

JACOB FREEDMAN, Franklin and Marshall College. Geochemical Exploration for Mineral Deposits in Lancaster County.

GARY B. GLASS, Pennsylvania Geological Survey. Computer Programs in Coal Geology. Two computer programs have been completed. The first upgrades an "as received" proximate coal analysis to a moisture-free and a moisture and ash-free basis; this program also upgrades sulfur contents and B.T.U. values. The second program performs a weighted average for an unlimited number of separate proximate analyses; this second program was designed to recombine proximate analyses of separate portions (benches) of a coal seam into a theoretical composite analysis of the entire seam.

KARL V. HOOVER, Pennsylvania Geological Survey. Clay-Shale Resources of the Pittsburgh Trade Area. Field and laboratory evaluation of the clay and shale deposits in southwestern Pennsylvania.

KARL V. HOOVER, Pennsylvania Geological Survey. Atlas of Pennsylvania Mineral Resources: Part 2 - Clays and Shales. Compilation of all geologic information of Pennsylvania's clays and shales. The publication will be a collection of geologic maps, physical property and ceramic list data, chemical analyses, and summary tables of established and potential uses.

JOHN W. HOSTERMAN, U. S. Geological Survey. Northern Appalachian Clay Studies. Field work on this project is complete. A final publication will describe the underclays of Somerset and Fayette Counties, Pennsylvania.

DANA R. KELLEY and DAVID DEBOR, Pennsylvania Geological Survey. Subsurface Reservoir Core Analyses. Compilation of core analysis data into tabulations and graphs illustrating porosity, permeability, saturation, density, salinity, and other core data relationships by unit.

WILLIAM S. LYTLE, Pennsylvania Geological Survey. Crude Oil Reserves of Pennsylvania. To bring Survey publication M-32 "Crude Oil Reserves of Pennsylvania" up-to-date using chemical logs and core reports that were not available when M-32 was written. Considerable additional information is now available which will give more meaning to the reserve estimate.

WILLIAM S. LYTLE, DANA R. KELLEY, WALTER R. WAGNER, LOUIS HEYMAN, Pennsylvania Geological Survey. Oil and Gas Developments in Pennsylvania in 1970. A description of the developments during 1970 in search of oil and gas, including highlights, statistics, and general oil and gas data.

WILLIAM S. LYTLE, DANA R. KELLEY, WALTER R. WAGNER, LOUIS HEYMAN, Pennsylvania Geological Survey. The Petroleum Industry and the Future Petroleum Province in Pennsylvania, 1970. A review and forecast of the petroleum industry in Pennsylvania for stimulating and promoting the industry in the state by demonstrating the demand and need for new hydrocarbon reserves and the exceptional potential for discovery of such reserves with improved technology, and new ideas and operating methods.

JAMES P. MINARD, U. S. Geological Survey. Southeast Appalachian Sediments. Investigations of potential mineral depostis, especially heavy metals, in the Atlantic Coastal Plain and eastern Triassic basins.

JOHN SLAUGHTER and H. LAWRENCE McKAGUE, Rutgers University. Genesis of the Stratiform Copper Deposits of the Catskill Formation in Northeastern Pennsylvania.

WALTER R. WAGNER and DANA R. KELLEY, Pennsylvania Geological Survey. Surface Middle Devonian (Onondaga) Economic Stratigraphy of Western Pennsylvania. To erect a stratigraphic framework for Upper Devonian, Mississippian and Pottsville (Pennsylvanian) rocks of western Pennsylvania. The work is to be completed in three phases. Phase I, showing major subdivisions of Upper Devonian Rocks, is published (Pa. Geol. Survey PR 178). Phase II, in process, consists of a network of cross sections tying subsurface data (geophysical well logs) into surface sections. The sections will show hydrocarbon reservoirs, gross stratigraphic changes, and position of fresh water, coal, limestone, clay and other major resources. Phase III - regional interpretation of Phase II employing isopach and lithofacies maps.

ENGINEERING GEOLOGY

A. J. DEPMAN and D. G. PARILLO, U. S. Army Engineer District, Philadelphia. Engineering Geology of the Tocks Island Reservoir Complex. Engineering geology of the entire project including foundation and rock mechanics studies for design recommendations and maximum use of required excavation and local materials for construction purposes; effect of structures on ground water. Pleistocene geology highlighted and studied in detail; Silurian Bloomsburg Formation through Devonian Catskill studied.

NORMAN K. FLINT and JAMES V. HAMEL, University of Pittsburgh. Analysis and Design of Highway Cuts in Rock: A Slope Stability Study on Interstate Routes 279 and 79 near Pittsburgh, Pa.

JOHN R. HARRIS and MARSHALL A. NELSON, U. S. Army Engineer District, Philadelphia. Engineering Geology of Blue Marsh Reservoir. Engineering geology of the entire project including foundation studies for design recommendations and maximum use of local materials for construction purposes; environmental studies for recreation purposes and for quality of water. Ordovician geology highlighted.

KARL V. HOOVER, Pennsylvania Geological Survey, RICHARD HOWE and DAVID REIDENOUR, Pennsylvania Department of Highways. Engineering Properties of Shales for Highway Granular Material Use. Investigations of engineering properties of shales for use as a granular material for highway construction. A major endeavor of the project is to establish testing standards for selecting suitable shales.

R. G. LAZOR and A. J. DEPMAN, U. S. Army Engineer District, Philadelphia. Final Foundation Report - Beltzville Dam, Lehighton, Pennsylvania. Final foundation report highlighting structural geology encountered during construction of Beltzville Dam; details foundation treatment including pressure grouting, dental treatment, and high velocity concrete treatment of abutment area. Foundation rock is fossiliferous Devonian Mahantango Formation; axis of dam and pertinent structures located normal to axis of Lehighton anticline.

ENVIRONMENTAL GEOLOGY

WILLIAM B. FERGUSSON, Villanova University. Geological Approach to Man's Environment. Environmental problems related to the geology of the area illustrated with case studies from the author's experiences.

ALAN R. GEYER and WILLIAM G. McGLADE, Pennsylvania Geological Survey. Environmental Geology for Land-Use Planning. Guide to the value of geology in all phases of land-use planning, design, and construction.

MARY E. HORNE, Pennsylvania Geological Survey. Environmental Geology of the Greater York Area. This study involves the incorporation of basic geologic mapping with soils mapping, ground water data, mineral resource data, and engineering characteristics of rock formations with the application of these data to present land use in the area and to projected growth needs.

DANA R. KELLEY, Pennsylvania Geological Survey. Clay-shale Related Landslides in the Pittsburgh, Pennsylvania Area. As a means of informing industry, government, and the public of the serious landslide hazards existing in and about Pittsburgh, a short compilation of existing knowledge and causes of these slides is being prepared, including a map of slides of record, general cross sections illustrating stratigraphic variation in hazardous zones and selected illustrations, diagrams, and graphs.

WILLIAM G. McGLADE, Pennsylvania Geological Survey. Environmental Geology of the Harrisburg Metropolitan Area. Compile, reinterpret and add basic geology, ground water, mineral resource and engineering data for the Harrisburg Metropolitan area. The purpose of this study is to apply geological principles, interpretation of data toward an understanding of the subject area that will be immediately useful to planners, engineers, government officials, and the general public.

WILLIAM G. McGLADE, J. P. WILSHUSEN and A. R. GEYER, Pennsylvania Geological Survey. Engineering Characteristics - Rocks of Pennsylvania. Project covers geologic, engineering, and ground water characteristics of each rock formation described on the 1960 State Geologic Map. Material will be presented in chart form and is intended as a supplement to the State Geologic Map.

NEILSON RUDD, Geo-Engineering Laboratories, Inc. The Feasibility of Subsurface Liquid Waste Disposal in Pennsylvania. The project consists of three phases: 1) a comprehensive review of the principles of deep well disposal, 2) a discussion of techniques and guidelines for site selection, evaluation, and operational monitoring, and 3) a regional survey of potential disposal reservoirs within the Commonwealth of Pennsylvania.

S. F. THOUMSIN and J. R. NIEHEISEL, U. S. Army Engineer District Philadelphia. Delaware River Estuary - Nature, Source and Cause of Shoaling. Part III of a seven part study on Long Range Disposal Areas for Delaware River Shoals. Purpose of study is to provide basic data on the physio-chemical properties of principal shoal areas, the sources, and mechanisms causing their formation. In due course extensive petrologic studies are to be made. In addition the potential agricultural value of the sediments was studied.

GENERAL GEOLOGY

ERNST CLOOS, Johns Hopkins University. Geology of the Thomasville Area, York County. This will complete a study which began in 1935 and continued since then. It includes Kinzers and Vintage stratigraphy at Thomasville, structural geology, some economics, and historical development. Dolomite and dolomitization and a few fossils will be included.

ALAN R. GEYER, Pennsylvania Geological Survey. A Geologic Guide to Rickett's Glen State Park. A geologic description of Rickett's Glen State Park with special emphasis on the origin of the waterfalls.

DONALD HOFF, Pennsylvania Historical and Museum Commission. Planning of Permanent Earth Science Exhibits for the William Penn Memorial Exhibits.

BION H. KENT, U. S. Geological Survey. Geology of the Mather-Garards Fort Area, Southwestern Pennsylvania. Project objectives include (a) geologic quadrangle mapping at 1:24,000 scale; (b) sedimentological studies, primarily of lithofacies trends and their effects upon associated coal beds; and (c) evaluation of coal resources, primarily in the Pittsburgh, Sewickley, and Waynesburg coal beds.

DAVIS M. LAPHAM and ALAN R. GEYER, Pennsylvania Geological Survey. Common Rocks and Minerals of Pennsylvania. A complete rewrite of the Survey's Education Series No. 1 booklet.

WILLIAM S. LYTLE and LILLIAN HEEREN, Pennsylvania Geological Survey. Principal Crude Oil, Product and Natural Gas Pipelines. Brings the pipelines map up-to-date showing changes, refineries and gas storage fields.

WILLIAM G. McGLADE, Pennsylvania Geological Survey. Pennsylvania Trail of Geology - The Grand Canyon of Pennsylvania. A geological description of the Pennsylvania Grand Canyon for the lay reader.

GEOCHEMISTRY

DONALD LANGMUIR and DONALD O. WHITTEMORE, The Pennsylvania State University. The Nature of Yellow-boy Precipitates from Acid-mine Waters. Examination of the physical and chemical properties of ferric oxyhydroxides precipitated by oxidation and/or hydrolysis of acid-mine waters.

DAVIS M. LAPHAM, Pennsylvania Geological Survey. Isotopic Dating of Precambrian Schists, Erie County. Correlation and significance of K-Ar and Rb-Sr age dates on Precambrian metasediments from drill cores beneath the Plateau.

DAVIS M. LAPHAM, S. ROOT, and D. MACLACHLAN, Pennsylvania Geological Survey. Isotopic Dating in the Reading Prong of Pennsylvania. Correlation and Significance of K-Ar dates in the Pennsylvania Reading Prong.

DAVIS M. LAPHAM and S. ROOT, Pennsylvania Geological Survey. Isotopic Dating in the Blue Ridge of Pennsylvania. Correlation and significance of U-Pb, K-Ar, and Rb-Sr dates in the Pennsylvania Blue Ridge.

DAVIS M. LAPHAM and S. ROOT, Pennsylvania Geological Survey. Isotopic Dating of Faulting in the Great Valley of Pennsylvania. Significance of K-Ar dates on fault gouge and enclosing sediments in the Pennsylvania Great Valley.

H. LAWRENCE MCKAGUE, Rutgers University. Trace Element Distribution in State Line Serpentinite.

ARTHUR W. ROSE and DAVID C. HERRICK, The Pennsylvania State University. Geochemistry of the Cornwall Iron Ore Deposit. The main emphasis of the project is on oxygen isotope abundance, supplemented by considerable chemical and mineralogical work, in order to interpret temperature and other conditions of ore formation, and processes of ore formation.

ARTHUR W. ROSE and ROBERT C. SMITH II, The Pennsylvania State University. Geochemistry of Triassic Diabase. The abundance of trace and major elements has been determined in about 100 chilled border samples and in several suites of samples through sheets. The results are being used to better understand the origin of the diabase magma and the associated ore deposits.

ARTHUR W. ROSE, JAMES McNEAL, and M. L. KEITH, The Pennsylvania State University. Geochemistry of Pennsylvania Stream Sediments. Present work is concentrated on the abundance of mercury in stream sediments, and on the partition of Cu, Zn, Ni, Co, and Pb between exchange sites, organic matter, iron oxides, sand, silt and clay fractions. Statistical techniques are being used to improve resolution of anomalies in a large group of samples covering the southeastern part of the state.

F. K. SZUCS, Slippery Rock State College. Correlation and Absolute Age Determination of the Slippery Rock Till. Exposures of the Slippery Rock Till were correlated by using neutron activation techniques.

PETER W. WEIGAND, University of North Carolina. Geochemistry of Pennsylvania Triassic (?) Dolerite Dikes. This project is part of a larger study concerned with the geochemistry of the eastern North American Triassic (?) dolerite dikes.

GEOMORPHOLOGY

DONALD R. COATES, State University of New York at Binghamton. Terrain Comparison of the Glaciated and Non-Glaciated Appalachian Plateau. This is largely a quantitative and computergraphic morphometry study of the 1:62,500 scale topographic maps in a 20,000 square mile region.

RICHARD A. MARTIN, Millersville State College. Devil's Race Course Boulder Field, Dauphin County.

WILLIAM B. WHITE, The Pennsylvania State University. Caves of Pennsylvania. Progress has been made in compiling a new comprehensive catalog of the caves of Pennsylvania. Work on the western portion of the state is complete and data for the Piedmont and Great Valley are nearing final form.

GEOPHYSICS

RONALD R. HARTMAN, Aero Service Corporation. Development of a digital recording-computer contouring package for radioactivity survey data. Aero Service Corporation has recently completed the installation of a new airborne geophysical survey package in an Aero Commander aircraft. The package includes a magnetometer with a sensitivity of 1/10 gamma, a scintillation counter with spectral channels to detect radiation in the uranium, potassium and thorium emission ranges, and a digital recording system which records barometric and terrain clearance altitudes as well as the geophysical data. At the heart of the system is a doppler navigation installation which provides a ground distance base for the recording of all data. The system is designed for mineral exploration work.

PETER M. LAVIN, The Pennsylvania State University. Iron Ore Geophysics. The purpose of the study is to search for characteristic geophysical responses which can be used in distinguishing between aeromagnetic anomalies in the Triassic Basin of southeastern Pennsylvania due to massive magnetite deposits (of possible economic importance) and anomalies due to diabase intrusives (disseminated magnetite).

GLACIAL GEOLOGY

DONALD R. COATES, State University of New York at Binghamton. Mastodon Bone Age and Geomorphic Relations in the Susquehanna Valley. A massive 20-inch bone has been identified as a pelvic fragment of a mastodon, *Mammut americanus,* and has yielded a Carbon-14 date of 13,320 – 200 yrs. B.P. The bone was discovered in a gravel pit, 11 feet below the gound in a terrace along the valley of the Chemung River.

GEORGE W. CROWL, Ohio Wesleyan University. Pleistocene Geology of the Delaware Valley, Matamoras to Shawnee on Delaware.

DENIS E. MARCHAND, Bucknell University. Pre-Wisconsin Pleistocene Stratigraphy and Chronology of the Central Susquehanna Region.

WILLIAM D. SEVON, Pennsylvania Geological Survey. Investigation of characteristics of a small boulder field which is adjacent to the Wisconsin 'terminal' moraine and overlies Wisconsin outwash sediments.

STANLEY M. TOTTEN, Hanover College. Fossil Beetles from Wisconsinan Peat, Titusville, Pennsylvania. A 40,000 year old peat deposit at Titusville, Pa., has yielded the remains of 750 individual beetles, many of which have been identified to genus and species. The species identified have a northern distribution and are found typically in the Hudsonian Zone of Canada.

HYDROLOGY

ALBERT E. BECHER and **WALTER S. WETTERHALL**, U. S. Geological Survey. Urban and Rural Ground Water Hydrology in the Northern Part of the Cumberland Valley, Pennsylvania.

JAMES DIAZ and **RICHARD R. PARIZEK**, Geo-Technical Services and The

Pennsylvania State University. Effects of Spray Irrigation of Sewage Effluent on Ground Water. Soil tests and ground water data from exploration holes in deep residual soils (Wissahickon) at the site indicate suitable conditions for spray irrigation of effluent from aerated sewage lagoons (now under construction). Irrigation rates, nutrient content, growth rate of crops and nursery stock, effects on surface and ground water will be monitored and recorded for several years.

JAMES DIAZ and RICHARD R. PARIZEK, Geo-Technical Services and The Pennsylvania State University. Investigation of Safe-yield of Aquifer. An investigation using electrical analog modeling techniques and digital computer will be made this summer to predict the sustained safe-yield of an aquifer of Cockeysville Marble surrounded on three sides by Wissahickon schist.

MARILYN GINSBERG, State University of New York at Binghamton. Relationship between the Geology and the Geohydrology of the Triassic Basin in Pennsylvania.

JERRALD R. HOLLOWELL and HARRY E. KOESTER, U. S. Geological Survey. Ground Water Resources of Lackawanna County. Project is to evaluate and appraise the ground water resources in the county.

DONALD LANGMUIR and WILLIAM S. SANNER, JR., The Pennsylvania State University. Nitrogen and Phosphorus Variations in Ground Water beneath Farm Land, Mahantango Watershed, Pennsylvania. Investigations of controls on and variations in amounts of nitrogen and phosphorus in ground water in a part of the Mahantango Watershed, Pennsylvania.

DONALD LANGMUIR and ROGER L. JACOBSON, The Pennsylvania State University. Hydrogeochemistry of Ground Water in Carbonate Rocks. Study of how ground water in a carbonate rock terrane is related to gas-solution-mineral reactions, pollution, and hydrogeology.

DONALD LANGMUIR, RICHARD R. PARIZEK, and MICHAEL A. APGAR, The Pennsylvania State University. The Chemical Interaction of Sanitary Landfill Leachate with Unsaturated Soil in a Carbonate Rock Terrane. Investigation of the detailed physical-chemical processes which account for renovation of landfill-leachate in a soil, and the establishment of site-selection criteria for landfills in carbonate-rock terranes in Pennsylvania. An improvement in leachate quality occurs within unsaturated soil beneath landfills. Serious ground water pollution by leachates will occur if landfill materials come in contact with ground water.

ORVILLE B. LLOYD, JR. and DOUGLAS J. GROWITZ, U. S. Geological Survey. Ground Water Resources of Central and Southern York County. The investigation will evaluate the water-bearing and water-quality characteristics of the major bedrock units in the area of study.

THOMAS G. NEWPORT and JOHN GALLAHER, U. S. Geological Survey. Summary reports of the ground-water resources of each county in Pennsylvania.

WILLIAM B. WHITE and HENRY W. RAUCH, The Pennsylvania State University. Solution Kinetics of Carbonate Rocks. Empirical rates of solutions for various carbonate rocks in water at one atm CO_2 pressure have been determined in the laboratory. The variation in solution rate between rock lithologies correlates with the amount of solution cavity development observed in these rocks in the field.

WILLIAM B. WHITE and EVAN T. SHUSTER, The Pennsylvania State University. Chemistry of Limestone Spring Waters. The seasonal fluctuations in the chemistry of limestone spring waters reflect the type of aquifer system feeding the spring. Large fluctuations imply conduit systems with fast flow-through times. Small fluctuations imply diffuse flow systems. Most spring waters are found to be under-saturated with respect to $CaCO_3$.

CHARLES R. WOOD, U. S. Geological Survey. Ground-water Resources of the Clarion River and Redbank Creek Basins. Ground-water quality and availability will be studied with special emphasis on quality problems related to mining and active and abandoned oil and gas wells.

IGNEOUS AND METAMORPHIC GEOLOGY

W. A. CRAWFORD and P. G. ROBELEN, Bryn Mawr College. Petrological and Chemical Variations of the Honeybrook Anorthosite.

MINERALOGY

DAVIS M. LAPHAM and ALAN R. GEYER, Pennsylvania Geological Survey. Mineral Collecting in Pennsylvania. A continuing project to describe minerals and mineral localities in Pennsylvania.

WILLIAM B. WHITE, The Pennsylvania State University. Infrared Spectra of Hydrous Carbonate Minerals. Infrared spectra have been measured on the hydrous carbonate minerals artinite, nesquehonite, and hydromagnesite. The spectra were used to determine the positions and hydrogen bonding of hydroxyl ions and water molecules. Artinite and nesquehonite have similar structures and spectra results are consistent with the published structure of artinite. Hydromagnesite has a quite different structure based on hydroxide layers.

PALEONTOLOGY

DONALD BAIRD, Princeton University. Additions to the Vertebrate Fauna of the Upper Kittanning Coal (mid-Pennsylvanian) of Cannelton, Beaver County, Pennsylvania. A search of the old Survey collections at the William Penn Memorial Museum has yielded a specimen of the coelacanth fish *Rhabdoderma elegans* which seems to be the first record of a Carboniferous coelacanth in Pennsylvania. A search of the Princeton paleobotanical collection produced a specimen of the ubiquitous fresh-water shark *Xenacanthus compressus.* Both were collected by mine-owner I. F. Mansfield at Cannelton about 1877.

ROGER L. BATTEN and R. H. ROLLINS, American Museum of Natural History. Conemaugh-Allegheny Gastropods and Paleo-Ecology.

STIG M. BERGSTROM, The Ohio State University. Conodont Biostratigraphy of the Middle Ordovician of Pennsylvania.

ALBERT A. BERTI, University of Western Ontario. Pollen and Seed Analysis of the Titusville Section (Mid-Wisconsin), Titusville, Pa.

PETER W. BRETSKY, K. W. FLESSA, and S. S. BRETSKY, Northwestern University. Ecology of Late Ordovician Benthic Communities. The investigation was a study of the paleoecology of the fossiliferous beds at the top of the Reedsville and Martinsburg Formations. The area covered extended from central Pennsylvania to northern Tennessee.

JOHN A. CLENDENING, Pan American Petroleum Corp. Sporological Evidence on the Geological Age of the Dunkard Strata in the Appalachian Basin. Study of fossil spores and pollen from throughout the Dunkard strata substantiates an Upper Pennsylvanian rather than a Permian Age for the entire sequence of strata.

CHRISTOPHER J. DURDEN, Texas Memorial Museum. Systematics and Biostratigraphy of the Insects, Arachnids, and other Terrestrial Arthropods of the Pennsylvanian. European sub-epochs (Autunian A. Stephanian C & A-B, Westphalian D, C-D, C, B, A, and Namurian C) recognized in both bituminous & Anthracite fields on the basis of distribution of blattoid genera. "Cassville" fauna located in the Southern Anthracite Field in roof Black Mine Vein. "Cassville" genera occur in European Aut. A., not in Stephanian.

NILES ELDREDGE, American Museum of Natural History. Middle Devonian Trilobites.

HENRY FAUL, CAROL FAUL, and others, University of Pennsylvania. Beltzville Reservoir Paleontological Salvage. We are making a reference collection of fossils from the well known Mahantango Formation locality along Pohopoco Creek which will be flooded by the Beltzville Dam Reservoir.

WILLIAM H. GILLESPIE, West Virginia University and JOHN A. CLENDENING, Pan American Petroleum Corp. Age of Dunkard Group, Appalachian Basin.

ALBERT L. GUBER, The Pennsylvania State University. Paleoecology of Columbiana.

ALBERT L. GUBER and LYNN BRANT, The Pennsylvania State University. Paleoecology of Brush Creek.

JON D. INNERS, Pennsylvania Department of Highways. Stratigraphy and Paleontology of the Onesque Thaw Stage in Pennsylvania.

RICHARD LUND, University of Pittsburgh. Fossil Fishes from Southwestern Pennsylvania. Detailed paleontologic work with very close stratigraphic control, upon vertebrate-bearing beds from the Allegheny to the Dunkard, is in progress. A new genus of Lungfish, with a species is being described, as well as new species of fresh-water shark. Some understanding of stratigraphic succession of faunas is emerging.

WILLIAM H. PARSONS and DOUGLAS SCHAMEL, Allegheny College. Palynology of Peat and Lake Deposits of Crawford County, Pennsylvania. We are comparing pollen stratigraphy of lake bed sediments with stratigraphy of selected interstadial and postglacial peat deposits of eastern Crawford County.

HAROLD B. ROLLINS, RICHARD LUND, JACK DONAHUE, and ROGER BATTEN, University of Pittsburgh. Community Structure and Evolution in the Conemaugh of the Appalachian Basin.

CRAIG D. SHAAK, University of Pittsburgh. Brush Creek Limestone (Pennsylvanian) within the Appalachian Basin. This Ph.D. thesis is designed to establish lateral and vertical species diversification in the Brush Creek Limestone (Pennsylvanian) within the Appalachian Basin. The goal of the investigation is to reconstruct the fossil communities and their variations with respect to paleoenvironments.

KEITH S. THOMSON, Yale Peabody Museum. A new genus and species of lobe-fin fish from the Upper Devonian (Oswayo Formation) of Clinton and McKean Counties, *Hyneria lindae*, throws new light on the origin of the amphibians because it "shows a closer general resemblance to the Amphibia than any other known rhipidistian."

SEDIMENTARY PETROLOGY

ROBERT W. ADAMS, S.U.N.Y. College at Brockport. Compaction in Carbonates - Mechanisms and Significance.

WILLIAM R. KAISER, Johns Hopkins University. Sedimentology of the Mahantango Formation. Determine the geometry of the Montebello Sandstone Member and to unravel the coarsening-upward cycles. Investigate regional lithologic changes within Mahantango. Detailed petrology of the coarsening-upward cycles.

JOHN B. ROEN, U. S. Geological Survey. Petrology of the Pittsburgh Sandstone in the Northern Half of the Dunkard Basin.

ALLAN M. THOMPSON, University of Delaware. Upper Ordovician Clastic Wedge Deposits. Active parts of the project include two areas: (1) delineation of depositional environments and tectonic styles associated with the transition from flysch to molasse sedimentation in the Upper Ordovician Taconic clastic wedge deposits of the Reedsville Formation; and (2) color boundaries of the Juniata Formation. This area relates to redefinition of the major stratigraphic units present in the Upper Ordovician.

ROGER G. WALKER and JOHN C. HARMS, McMaster University. Catskill Delta in Central Pennsylvania. Sedimentological study of Catskill Delta establishment in Central Pennsylvania.

STRATIGRAPHY

ROBERT W. ADAMS and RICHARD M. LIEBE, S.U.N.Y. College at Brockport. Stratigraphic Analysis of Dolomitic Greenbrier Limestone. We are examining the dolomite-limestone facies of the Greenbrier-Loyalhanna Limestone stratigraphic interval in the tri-state area of Pennsylvania, Maryland, and West Virginia. Micropaleontological work with conodonts will be combined with petrographic and areal facies mapping to resolve time-stratigraphic problems in the area.

THOMAS M. BERG, W. E. EDMUNDS, A. D. GLOVER, and G. B. GLASS, Pennsylvania Geological Survey. Project TASIC. This project (Temporarily Available Stratigraphic Information Collection) is a continuing program involved with the recovery of stratigraphic data from active coal and clay strip mines and construction sites, while exposures are available. This long-term project is designed to provide data for future mapping and regional mineral resource evaluation. This information will also be useful in establishing the stratigraphic framework of coal-bearing rocks in western Pennsylvania, in making reserve calculations, in coal and coal land evaluation, in ground-water aquifer potential, in excavation and foundation information and in clay, shale, and other resource exploration.

JOHN M. DENNISON and DONALD M. HOSKINS, University of North Carolina and Pennsylvania Geological Survey. Purcell Limestone in Appalachian Basin.

JOHN M. DENNISON, University of North Carolina. Aspects of Silurian and Devonian Stratigraphy in Appalachian Basin.

JOHN M. DENNISON and DANIEL A. TEXTORIS, University of North Carolina. Stratigraphy and Petrology of Devonian Tioga Bentonite. Regional distribution of stratigraphic relations and thickness of tuffaceous beds of the Tioga Bentonite horizon, along with petrologic analysis of mineralogy and size distribution as related to probable source area.

A. C. DONALDSON, J. KIRR, R. HUGHART, R. NORECK, and L. HEFFNER, West Virginia University. Sedimentation patterns and tectonic elements of the Blacksville, West Virginia-Pennsylvania 15-Minute Quadrangle.

A. C. DONALDSON, West Virginia University. Upper Pennsylvanian System in West Virginia, Pennsylvania, and Ohio.

A. C. DONALDSON and J. KIRR, West Virginia University. Stratigraphy of the Blacksville, West Virginia-Pennsylvania 7½-Minute Quadrangle.

A. C. DONALDSON, West Virginia University. Use of Stromatolites for Recognition of Lithofacies of Cambrian and Ordovician Carbonates of West Virginia and Pennsylvania.

R. W. FAAS, P. BEGLUND and S. KAPLAN, Lafayette College. Analysis of some Triassic Border Fault Lithofacies. Great lithofacies variation exists adjacent to the north border of the Newark-Gettysburg Basin in Pennsylvania. Three phases of research are being considered, the first of which is presently underway; 1) The mapping, description, and analysis of the border fault lithologies and their depositional mechanism(s); 2) reconstruction of rock provenance for each separate fan-like deposit; and 3) analysis of primary rock features related to the lacustrine environment.

HELMUT GELDSETZER, Queens University. Stratigraphic and Tectonic Patterns of the Devonian in Northeastern North America. The objectives of the study are to trace pronounced faunal and lithic breaks throughout the above area, to establish sedimentologically sound facies relationships for each depositional episode, and to determine the amount of erosional removal prior to a new depositional episode.

J. DOUGLAS GLAESER, Pennsylvania Geological Survey. Triassic Sediment Properties as Climatic Indicators. Rock composition, sedimentary cycles, calcretes, cross bed and pebble orientations, limestone debris-flow fans, algal structures, and alluvial fan deposits suggest arid climate sedimentation.

J. DOUGLAS GLAESER, Pennsylvania Geological Survey. Internal Geometry of Triassic Alluvial Fan, Basal New Oxford Formation. Multi-directional exposures in abandoned strip pits of basal New Oxford conglomerates show details of sedimentary properties and primary structures of alluvial gravel fan developed on the pre-Triassic surface.

J. DOUGLAS GLAESER, Pennsylvania Geological Survey. Correlation and Environmental Interpretation of Upper Devonian Rocks in Northeastern Pennsylvania. Regional study of surface and subsurface Upper Devonian sections in terms of depositional origin of correlatable stratigraphic units. Hydrocarbon, flagstone, and artesian water distributions are controlled by sedimentological character of the associated stratigraphic units.

KENNETH HASSON and JOHN DENNISON, East Tennessee State University. Stratigraphy of Harrell Shale and Millboro. Harrell Shale of Pennsylvania is a tongue of the Millboro Shale black shaly facies of Virginia. The Tully Limestone forms a marker horizon associated with the Harrell and Millboro.

JAMES W. HEAD, Lunar Exploration Department, Bellcomm, Inc. Late Cayugan (Upper Silurian) and Helderbergian (Lower Devonian) Paleoenvironmental Stratigraphy and Basin Evolution.

LOUIS HEYMAN, Pennsylvania Geological Survey. Subsurface Correlation Sections, Tully (M. Devon.) - Queenston (U. Ordov.). Establish stratigraphic framework for subsurface sedimentary petrology studies of various producing and potential oil and gas reservoirs in this part of the geologic section. These reservoir rocks are also potential waste disposal zones. Other zones of potential value (brine production, evaporites) will be indicated.

WAYNE C. MARTIN and B. R. HENNINGER, Miami University (Ohio) and West Virginia University. The Mather and Hockingport sandstone lentils (Pennsylvanian and Permian) of the Dunkard Basin, Pennsylvania, West Virginia, and Ohio.

W. C. MARTIN and D. M. LOREN, Miami University (Ohio). Integrated Facies Analysis of the Dunkard Group.

C. E. PROUTY, Michigan State University. Revision of the Chazy of Pennsylvania. The stratigraphy of the Chazy rocks is being studied in regard to their lateral relationship between eastern and central Pennsylvania; between eastern Pennsylvania and the Maryland and Virginia outcrop; and to their subsurface extensions into western Pennsylvania and West Virginia. Measured sections and most fossil collections have been made from the Pennsylvania outcrop.

JOHN B. ROEN, U. S. Geological Survey. Stratigraphy of the Coal-bearing Rocks of the Monongahela and Dunkard Groups in the Northern Part of the Dunkard Basin. Fifteen regional stratigraphic cross sections have been constructed showing the correlation and facies trends of the coal-bearing rocks of the Monongahela and Dunkard Groups in Ohio, Pennsylvania, and West Virginia.

HAROLD B. ROLLINS, JACK DONAHUE, NORMAN FLINT, and RICHARD LUND, University of Pittsburgh. Depositional Environment of the Conemaugh in the Appalachian Basin.

PETER G. WALDO, University of Massachusetts. Taconic Unconformity. The study is a problem for a Ph.D. thesis. It is a combined stratigraphic and structural study of the taconic unconformity in Pennsylvania, New York, and New Jersey. Emphasis is being placed on stratigraphic nature of the unconformity, geometry of pre-unconformity folds, and deformation of the unconformity during the Appalachian Orogeny.

STRUCTURE

INA B. ALTERMAN, Columbia University. Structural and Tectonic History of the Taconic Allochthon and Autochthon, East-Central Pennsylvania. Detailed geologic mapping of the eastern end of the so-called "Hamburg Klippe". Investigation includes mechanisms into the formation and deformation of the slaty cleavage and the relationship of these to the tectonic events, mechanisms of emplacement of allochthonous sequences, and relations of these events to a larger regional tectonism.

HAROLD C. FRY, JR., University of Pittsburgh at Johnstown. Limestone Border Conglomerate in the Vicinity of Bowmansdale.

RAYMOND R. KNOWLES, City College of New York. Study of Deformation Lamellae in Quartz in the Tuscarora-Juniata-Bald Eagle Formations near Milroy and the Tuscarora Formation at the Delaware Water Gap.

R. POWELL, P. J. CONEY, and L. MEADE, White Pigment Corp. Structure and Stratigraphy of Kinzers Formation. Structural Interpretation of West York Quarry (Kinzer Formation) and Definition of Recognizable Stratigraphic Units.

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SURVEY ANNOUNCEMENTS

THE SURVEY UP-DATES ITS X-RAY EQUIPMENT

In 1957, the Pennsylvania Geological Survey bought its first x-ray equipment. By 1969, this equipment was not only outmoded by new advances in technology, but, as a result of almost constant usage, was beginning to have as much "down-time" for repairs as available running time. Consequently, the two new units pictured on the cover have been installed to replace two similar, earlier units. The new equipment comprises a vacuum x-ray spectrograph (left-center) and a solid state, modular power and control unit (right).

The x-ray spectrograph will allow semi-quantitative and quantitative chemical analysis for elements heavier than sodium. For many elements, the limit of detection will be less than 0.01 percent. The power and control unit contains the strip-chart recorder upon which the spectrographic curves are traced. It also serves as the control and recorder for the x-ray diffraction (mineral analysis) unit to the left of this picture.

This new equipment in the Mineral Resources Division will allow the Survey to perform a wider range of rock and mineral analyses with greater accuracy than was previously available with the old equipment. Some of the studies that will utilize this equipment are: 1) analyses of clay and shale resources in Pennsylvania; 2) the potential uses of glacial materials (clays, aggregate, ground water, availability); 3) the character and uses of Cumberland Valley carbonate rocks; 4) engineering problems involving rock slides; 5) the rocks and economic geology of the Pennsylvania serpentinite belt (crushed stone, chromite, nickel, magnesite, talc); and 6) the iron-ore deposits of Pennsylvania. Besides these projects, this equipment can be used for more routine service work for the Survey staff, for other governmental agencies, and for the public when the proglem is of sufficient importance to justify the use of such complex, sophisticated instrumentation.

SECONDARY OIL RECOVERY OPERATIONS IN PENNA.

As of December 31, 1969, there were 75 waterflood projects in Pennsylvania, encompassing 30,850 acres. About 10,000 water injection wells were injecting 350,000 barrels of water per day into the producing horizons at pressures of 600 to 2,000 psi and about 9,000 wells were producing the flood oil from within the projects.

THE MINERAL INDUSTRY OF PENNSYLVANIA IN 1968

The Pennsylvania Geological Survey has published "The Mineral Industry of Pennsylvania in 1968" as Information Circular 69, by Charles Yeloushan of the United States Bureau of Mines. This publication is a concise summary of the quantity and dollar value of the reported production by commodity and by county of Pennsylvania's important mineral industries. Also included are uses, users, and a list of principal producers. The publication also is a storehouse of miscellaneous factual information ranging from the number of scraper loaders used in anthracite mining (131) to the winner of the "Sentinels of Safety" award for the most injury-free man-hours of work in quarrying operations (given to the Millard Quarry, Bethlehem Steel Corp., Annville, Lebanon County).

In 1968, Pennsylvania's mineral industries attained a total value of $904 million, a $5.6 million increase over 1967. Bituminous coal production was the leading producer ($408.9 million with Washington County being the largest producer; stone was the second largest commodity ($108.1 million); anthracite ($97.2 million), sand and gravel ($31 million), and natural gas ($24.4 million). The cement industry, including Portland and masonry, totaled $123.1 million, representing nearly a 10 percent increase over 1967 production. Other increased production was shown by copper, stone, gold, silver, clays, sand and gravel, cobalt, iron ore, mica, and pyrite.

This publication may be obtained at no cost from the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pa. 17120.

ANNUAL FIELD CONFERENCE
of
PENNSYLVANIA GEOLOGISTS

October 2-3, 1970 Field trip through eastern Piedmont of Maryland. Hosts: Maryland Geological Survey. Pre-registration by Pennsylvania Geological Survey, Harrisburg.

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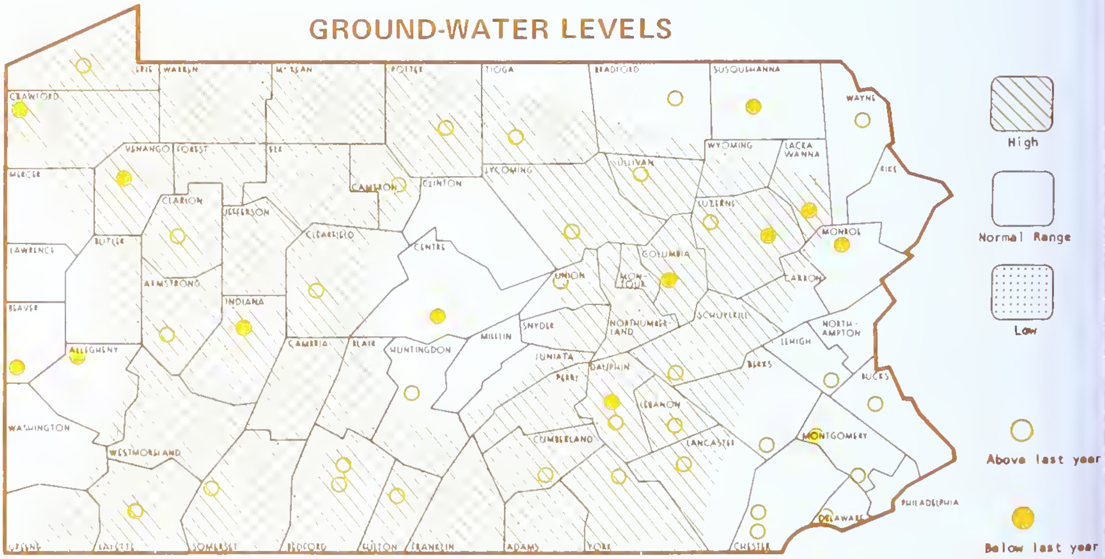

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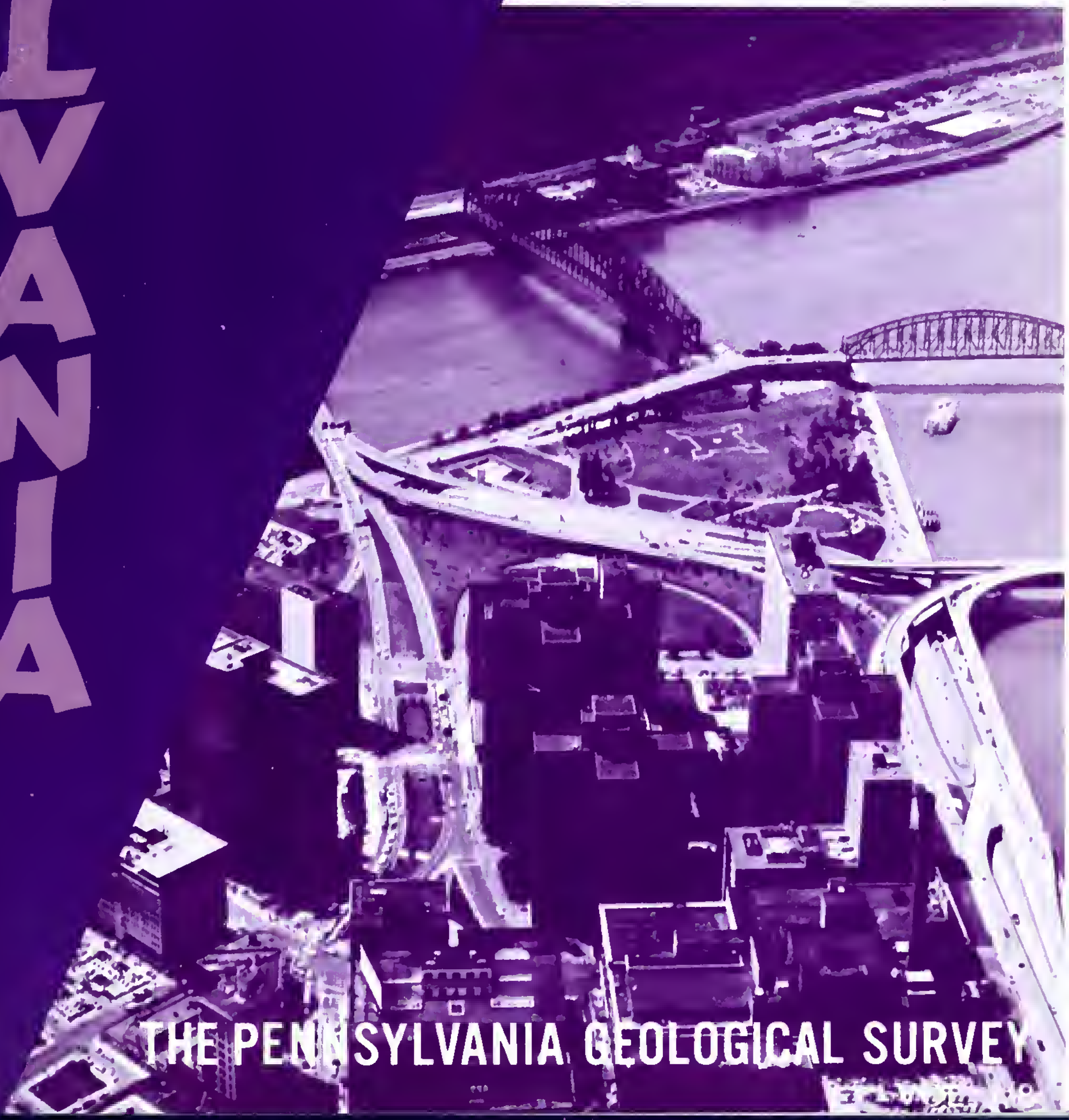

THE PENNSYLVANIA GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
Raymond P. Shafer, Governor

STATE PLANNING BOARD
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Topographic and Geologic Survey
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CONTENTS

The State Geologist Reports 1
Geology of the Pittsburgh Area Published 2
Disconformity Exposed 3
Surface to Middle Devonian Sections
    Placed on Open File 4
Coal Analyses and Strip Mine
    Descriptions Available 6
Limonite Concretions in Clearfield County 8
Earth Science Teachers' Corner 10
Quartz Roses for Your Rock Garden 11
Fossils From "Down Under"
    Found in Pennsylvania 12
Survey Announcements 13
New Survey Publications 16

ON THE COVER—Aerial view of the "Golden Triangle" and downtown Pittsburgh, center of the region covered in the Pennsylvania Geological Survey's new **Geology of the Pittsburgh Area**. Photo courtesy of the Pennsylvania Department of Transportation.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

OCTOBER 1970

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

GEOLOGY FOR ALL!

In this issue we are announcing the publication of the Survey's Latest book, **GEOLOGY OF THE PITTSBURGH AREA.** With the growing interest of man in his natural environment, with thousands of Pennsylvania children taking courses in Earth Science, and with geology becoming a household word thanks to our lunar astronauts, we believe a well written, nontechnical, illustrated report on local geological features will be utilized by a wide audience.

Certainly the Pittsburgh Area offers a choice environment of geologic features and a history greatly influenced by geology. The very development of that great steel center is due to the presence of vast coal and limestone resources needed for steel-making furnaces. The great Monongahela, Allegheny, and Ohio Rivers have served as major arteries of transportation. The sharply rolling topography has resulted in natural and man-made cuts which have exposed great thicknesses of rock layers visible to every resident of the Pittsburgh Area.

At the Survey office we have been receiving a growing number of requests from all over the State for geologic field trip guides and for explanations of geologic features observed by travelers. People are asking for suggestions where they might travel to see unusual geologic features, and where they might collect various rocks, minerals, and fossils. Schools, scout groups, mineral clubs, summer camps, conservation workshops, and "golden age" groups are all increasingly interested in their geologic surroundings. We are pleased to see this healthy trend and are making every effort to be of assistance. **GEOLOGY OF THE PITTSBURGH AREA** is one such example.

Arthur A. Socolow

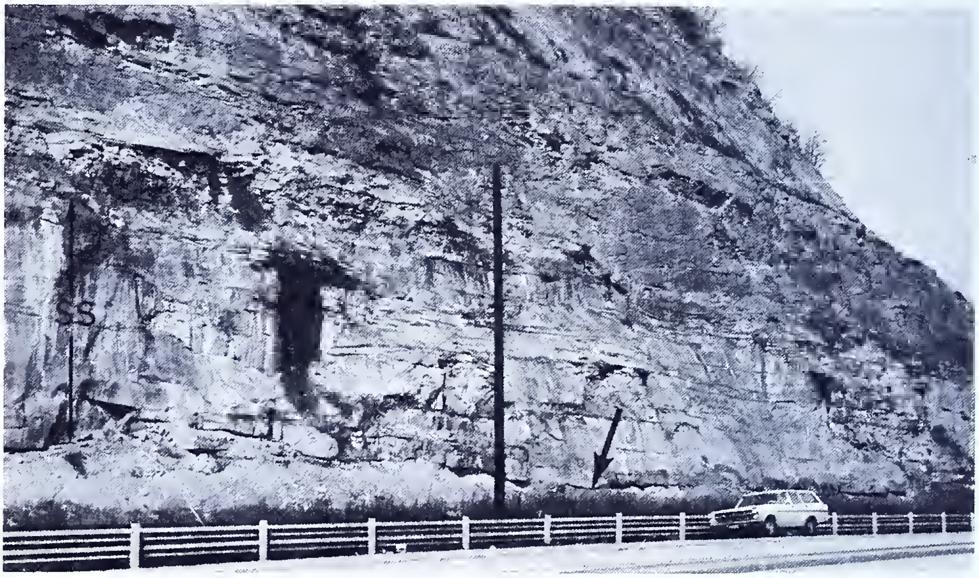
GEOLOGY OF THE PITTSBURGH AREA PUBLISHED

A new guide to geologic features and geologic history of the Greater Pittsburgh Area has been issued by the Pennsylvania Geological Survey. **GEOLOGY OF THE PITTSBURGH AREA** was authored by Walter R. Wagner and other members of the Pennsylvania Survey staff, as well as members of the Pittsburgh Geological Society.

The 145-page, well-illustrated book presents a description and interpretation of the geology in and around Pittsburgh with emphasis on specific localities that the reader may readily visit. A county locality map in the book will help to plan field trips to the points of interest. The localities were carefully selected to illustrate basic principles of geology. The role of geology in the historical and economic development of Pittsburgh is covered in the sections dealing with soils, landslides, mine subsidence, and mineral resources.

GEOLOGY OF THE PITTSBURGH AREA will be of interest to a wide range of readers. The general public, both adult and of school age will better appreciate the fascinating array of geologic features which are abundantly displayed around Pittsburgh. Earth Science teachers and all interested in environmental features will find the book an excellent outline and guide to Pittsburgh area geology. The glossary, extensive bibliography, detailed diagrams and photographs in the book make it an excellent teaching aid and source book.

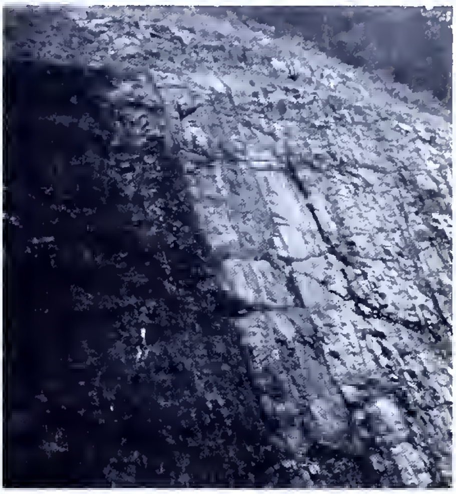
GEOLOGY OF THE PITTSBURGH AREA, Bulletin G 59, is available from the Bureau of Publications, P.O. Box 1365, Harrisburg, Pa. 17125, for $1.00 plus sales tax.



Outcrop of Morgantown sandstone (ss) along Kennywood Boulevard. Arrow shows position of basal conglomerate.

DISCONFORMITY EXPOSED

Magnificently exposed in a new road cut at Blue Mountain where Interstate 81 passes through Swatara Gap, about 25 miles northeast of Harrisburg, are vertical beds of sedimentary rock. The relationship between these strata illustrates an important geologic principle. The dark rocks to the left are shales and thin siltstone beds of the Martinsburg Formation of Ordovician age. The lighter colored rocks to the right are quartzites and conglomerates of the Tuscarora Formation of Silurian age. The contact between the two formations is a systemic boundary but in this case it also happens to be a surface of unconformity. An unconformity is a surface of erosion or nondeposition that separates younger strata from older rocks. Where the beds are parallel on opposite sides of the unconformity, as in this instance, it is more properly termed a disconformity. Where older beds below the unconformity are inclined at a steeper angle than the younger strata it is termed an angular unconformity.



An angular unconformity may easily be recognized in a single outcrop because of the difference in inclination of the strata. A disconformity is more difficult to recognize because in a single outcrop strata appear to be part of a continuous sequence. Disconformities are usually recognized as a consequence of a regional study. In this instance it is known that in the southern part of the state two other formations normally occur between the Martinsburg Formation and the Tuscarora Formation and that there is continuous deposition or conformity between these strata. Also, if the Tuscarora Formation, or its equivalents, are traced northeast into New Jersey it is deposited on successively older rocks until ultimately it is deposited with an angular unconformity in Precambrian igneous rocks. This illustrates another important aspect of unconformities—they increase in magnitude toward the edge of a sedimentary basin and towards the center of a sedimentary basin they decrease in magnitude, ultimately passing into conformable strata.

Unconformities are no mere academic curiosity. They have considerable significance in the search for minerals, and as such are mapped and studied in detail. Oil or gas occurs frequently at or near an unconformity surface—indeed

(Continued on Page 9)

SURFACE TO MIDDLE DEVONIAN SECTIONS PLACED ON OPEN FILE

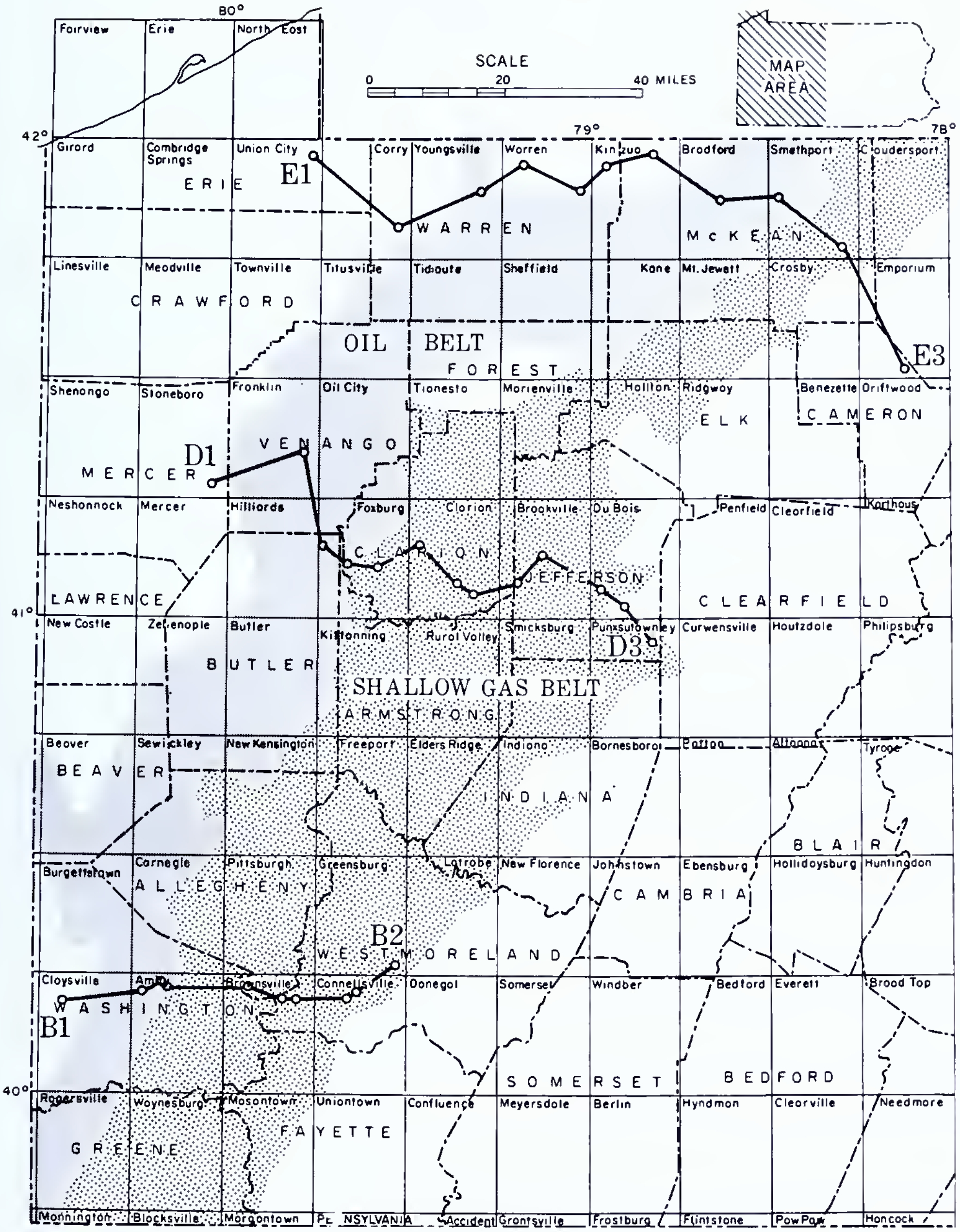
The first three regional gamma-ray log cross sections of the Survey's current study of **Surface to Middle Devonian Economic Stratigraphy** have been placed on open file to make the data of this important project available for immediate use. The location of these initial sections is shown in the figure. Included with the cross sections are an illustration of the regional stratigraphic setting of the sections, and a table showing the position of subsurface names with respect to zones defined in the report. Other cross sections are in progress and upon completion of these, all of the sections will be published together.

The purpose of the cross section is multifold:

1) to establish regionally consistent correlations and to delineate prominent reservoir zones and important changes in thickness and facies,
2) to indicate occurrence of fresh and salt water where reported in the locality of control wells and to mark the position of prominent coals, limestones, clays, and other resources, and
3) to reproduce gamma-ray logs at the same vertical scale (1 inch to 100 feet) as commercially available geophysical and sample logs, thus enabling these sections to be correlated directly with the commercial data.

Because geophysical logs themselves are basic data, they can be used independently of correlations and interpretations. Consequently, the cross sections will afford a basic reference network of geophysical logs for subsurface investigations, whether directed toward oil and gas reservoir distribution, subsurface disposal of effluent wastes, sources for brines or fresh water, potential pollution migration, or the distribution in the near subsurface of other exploitable resources such as coal, clay, limestone, dolomite, aggregate, and other construction material.

The cross sections may be examined in the Pennsylvania Geological Survey office, 401 Pittsburgh State Office Building, 300 Liberty Avenue, Pittsburgh.



MAP SHOWING LOCATION OF CROSS SECTIONS.

COAL ANALYSES AND STRIP MINE DESCRIPTIONS AVAILABLE

The Pennsylvania Geological Survey has placed on open-file more than 700 coal analyses representing samples collected from over 400 sites by staff coal geologists during the summers of 1966, 1967, 1968, and 1969. These surface coal samples were collected from active strip mines throughout the bituminous coal fields of Pennsylvania as part of a continuing program, which is designed to record temporarily available geologic data exposed in strip mines before the mines are backfilled. In addition to coal analyses, a complete description of the rocks exposed in the strip mine highwalls is also available for each site. The highwall descriptions include megascopic data on the coal and other rock types, thickness, color, bedding, sedimentary structures, vectorial features, concretions, fossils, jointing, faulting, slumping and weathering.

Each sample site is plotted on a 7½-minute topographic quadrangle map or on a 15-minute quadrangle where 7½-minute quadrangles are not available. In nearly all cases the operator's identification of the mined coal seam and frequently a staff member's evaluation of that identification is available.

All the coal samples collected before 1969 were analyzed by contracted, independent, analytical firms in 1969 and 1970. Only proximate analyses, sulfur determinations, and BTU (British Thermal Units) values are available for these samples and no attempt has been made to evaluate the effects of long-term indoor storage on the analyses of these samples. For this reason extreme caution must be taken when basing important decisions or conclusions on analyses of the pre-1969 samples. Post-1969 as well as future samples will be analyzed by the United States Bureau of Mines, under a cooperative program with the Survey, as soon after collection as possible. The United States Bureau of Mines is reporting complete ultimate and proximate analyses, BTU values, as well as the initial deformation temperature, softening temperature, and fluid temperature of the ash. The free-swelling index is also commonly reported.

The coal sampling technique used in this Survey program is unique and requires a few words of explanation. Each examined coal seam is separated into as many visibly different or physically separated benches as possible. Each bench is then individually channel sampled and analyzed. A typical coal sample is shown at the top of the next page as an illustration:

Clarion coal sample: 85-C-155

0 -11½ inches	Coal, very shaly (Separate analysis)
11½-22½ inches	Coal, bright (Separate analysis)
22½-23 inches	Bone parting (Not analyzed)
23 -40½ inches	Coal, bright (Separate analysis)
40½-41½ inches	Claystone parting (Not sampled)
41½-50 inches	Coal, bright (Separate analysis)
50 -53½ inches	Claystone parting (Not analyzed)
53½-56½ inches	Coal, bright (Separate analysis)
Composite (0-56½ inches)	Weighted average of all analyzed benches

In the above example, the coal sample consists of five separately analyzed benches. The composite analysis is a computer-calculated analysis made by mathematically combining the individual bench analyses into a theoretical total seam analysis. The individual-bench sampling method is primarily designed to show the vertical distribution of ash and sulfur in a coal seam and should prove useful in selective mining of low-ash or low-sulfur coals.

Obvious uses for these analyses and highwall descriptions are many and varied. Reserve computation, coal and coal land evaluation, ground-water aquifer potential, excavation and foundation information, clay, shale and other resource exploration, and regional stratigraphic correlation are but a few such uses.

These analyses and highwall descriptions may be examined by appointment at the Harrisburg office of the Pennsylvania Geological Survey, Room 210 (Rear), Old Museum Building, Harrisburg, Pennsylvania, 17120.

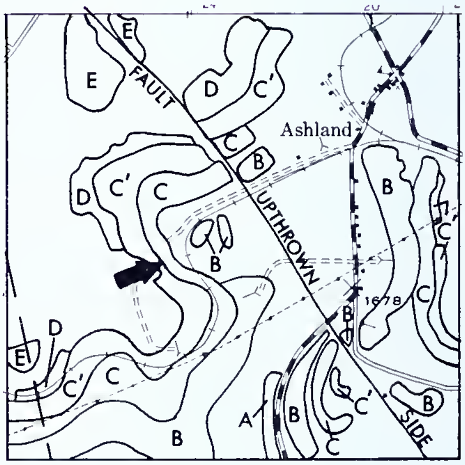
PENNSYLVANIA TOPS IN GAS STORAGE

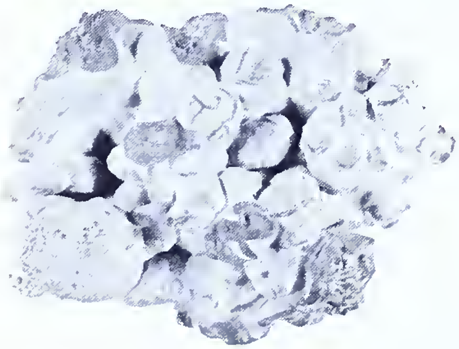
A volume of gas (nearly 5 trillion cubic feet) equal to one-fourth of last year's entire U. S. gas production can now be stored in the 320 natural gas storage reservoirs operated by 80 companies across the United States, according to the American Gas Association. The total output from storage last year was 1.4 trillion cubic feet with 21.6 billion cubic feet withdrawn on the maximum demand day.

The state with the most underground storage reservoirs is Pennsylvania with 63 whose capacities total 707 billion cubic feet. These reservoirs delivered 292 billion cubic feet from storage last year.

LIMONITE CONCRETIONS
IN
CLEARFIELD COUNTY

LOCATION: This locality is situated in the northwestern corner of the Houtzdale 7½-minute quadrangle in Decatur Township, Clearfield County, about ½ mile southwest of the village of Ashland, Pennsylvania and 2½ miles north of Houtzdale. The limonite occurs just above an abandoned, backfilled strip mine. Permission to collect should be obtained from Mr. L. T. Phillips in the Kittanning Coal Company office at 719 Lingle Street, Osceola Mills, Pennsylvania.





MINERALS:

Limonite:	earthy to compact septarian concretions; some botryoidal and stalactitic forms.
Coal:	medium-volatile, bituminous; as nearly horizontal seams.
Siderite:	nodular and lenticular concretions in shales over several of the coals; concretions often contain sphalerite and quartz crystals, occasionally pyrite and siderite crystals.

GEOLOGY: Nearly flat-lying Pennsylvanian Age (300,000,000 years old) rocks are exposed in six levels of strip mines in this area. These levels correspond to the six minable coal seams that outcrop in the vicinity of Ashland. These seams are listed below in descending order and strip mines on each of them are annotated with letters (A, B, C, C', D, and E) on the location map: Upper Freeport coal (E), Lower Freeport coal (D), Upper Kittanning coal (C'), Middle Kittanning coal (C), Lower Kittanning coal (B), Clarion coal (A).

The intervals separating these seams range between 30 and 70 feet in thickness while the rocks making up these intervening intervals consist of more or less rhythmic alternations of underclay, sandstone and shale with an occasional freshwater limestone. The minable coal seams vary in thickness from a minimum of 24 inches to a maximum of 54 inches. Thin (usually less than 12 inches) "rider" coals occur between several of the major seams and can be seen in the vertical faces (highwalls) of some of the strip mines.

A fault trends diagonally northwest-southeast through the locality area. Relative movement along this fault has caused the northeastern side to rise relative to the southwestern side. For this reason, the strip mines in the upper central portion of the location map show an apparent displacement of approximately 60 feet. In the southeastern corner of the area, the apparent displacement is much greater - on the order of 100 to 120 feet.

At this site, limonite has replaced nodules of freshwater limestone which usually occur in the underclay below the upper Kittanning coal. This replacement is the result of weathering processes. The limonite occurs as irregular to nodular concretions interspersed in a soft, plastic clay and now lying loose along and below the clay outcrop. The concretions are most commonly compact to earthy septarian boxworks although many specimens display botryoidal and stalactitic forms. Similar limonite concretions occur in the underclays beneath the Upper and Lower Freeport coals in this area. All of the strip mines in the area are backfilled except for a few very old ones. Collectors are warned to stay away from the steep strip mine highwalls because of the danger of falling debris and are also cautioned not to damage the seedlings that have been planted in the backfilled areas to reclaim the land. Do not enter any of the abandoned underground mines in the area as they are extremely dangerous and susceptible to collapse.

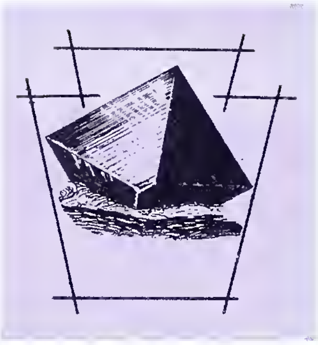
REFERENCE: Edmunds, William E. (1969), **Geology and Mineral Resources of the Northern Half of the Houtzdale Quadrangle,** Pennsylvania Geological Survey, 4th ser., Atlas 85 a-b, 150 p.

Gary B. Glass

(Continued from Page 3)

some of the largest petroleum deposits in the world are so associated. Nonmetallic minerals such as residual high-alumina clays, glass sands, and phosphates frequently are concentrated at unconformities. Some gold and platinum placer deposits and sedimentary uranium deposits are associated with unconformities. There are also instances where ore-forming solutions have migrated along unconformities and formed metallic replacement deposits.

Samuel Root



EARTH SCIENCE TEACHERS' CORNER

STILLWELL QUARRY

The Geologic Survey has received word recently from the owner of this very old and famous quarry that it is closed to mineral collecting. After one serious accident involving loose rock on the highwall of the quarry, the owner has closed the quarry to everyone. Please pass this word along to your students if they "dig" this quarry.

"WHERE CAN I FIND . . .?"

A very timely article on resources and references in the earth sciences appeared in the September 1970 issue of the Journal of Geological Education. Now that another school year has started, I am sure that many of you are asking this same question. Charles and Janet Wall of the Science Department of McFarland High School in McFarland, Wisconsin have written this impressive list of resources and references in the hope that new avenues of earth science materials will be opened. Contact any member of the National Association of Geology Teachers and ask to borrow his copy of the September Journal.

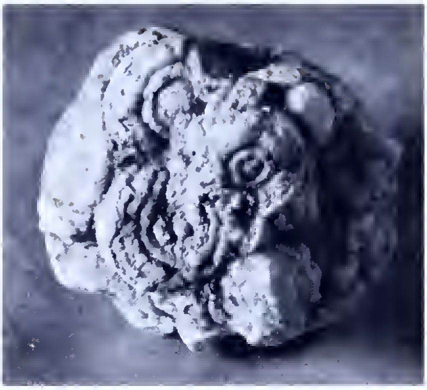
NEW MOON MINERALS

Armalcolite is a new mineral found in moon rocks returned by the Apollo 11 expedition. It was named in honor of Neil **Arm**strong, Edwin **Al**drin and Michael **Col**lins. Armalcolite crystallizes in the orthorhombic system, is an oxide of ferric iron, titanium, and magnesium, and resembles the Earth mineral pseudobrookite. It occurs in lunar basalts as minute, black, opaque grains.

Another mineral found in the Apollo 11 rocks is pyroxferroite, a close relative of the pyroxene minerals so common in earthly basalts. To date, pyroxferroite has not been found on the Earth. It occurs as small yellow grains and is essentially a ferrous silicate.

In general, the moon rocks so far examined are similar to terrestrial basalts. There are some minor chemical differences, however, such as higher concentrations of titanium, zirconium, and the rare-earth elements. There also is very little of the oxidized form of iron, ferric iron.

QUARTZ ROSES FOR YOUR ROCK GARDEN



An unusual form of quartz has been found recently in the Mechanicsburg area. The specimens seem to have a crude rosette structure, also sometimes referred to as "cabbage head" quartz.

A quick search of the literature turned up some mention of this occurrence locally but nothing on this "structure" of quartz could be found in standard mineralogical references. "Rosette chert" has been reported occurring at the top of the Rockdale Run Formation of the Beekmantown Group by Stose (1909, p. 7), Sando (1957, p. 24), and Root (1968, p. 31). The upper part of the Rockdale Run Formation typically consists of a fine-grained, mechanical limestone with numerous dolomite laminae. Although not seen in outcrop by the author, numerous pieces have been collected from the residual clayey soil at the horizon of the upper part of the Rockdale Run Formation in an abandoned stream channel near Mechanicsburg. The appearance of this material in float can be used as a mapping clue to this formation where outcrops are not available.

The photograph clearly shows their typical structure. Most "rosettes" are imperfectly developed. Where they are well developed, the quartz can be seen to have a banded, concentric structure, sometimes arranged around a small, spherical quartz core. The quartz in the bands is milky and the grains so small that they can be seen only with a high-power microscope. The "rosettes" usually completely encircle a specimen. For this reason, it is believed that they are not silica replacements of algal colonies. Such colonies have a definite growth pattern that is convex upward. Furthermore, slices made through groups of rosettes failed to show any of the regular structures characteristic of algal colonies.

Cut slices of rosette groups revealed that the inside of such a group contains rounded clear quartz grains in a matrix of hematite and limonite. All of this material occurs between rosettes. The two iron minerals strongly suggest that the quartz grew after (or perhaps during) oxidation or weathering. Thus, the rounded, probably detrital, clear quartz and the iron oxides are believed to have been included by the growing quartz rosettes. The colloform structure of the quartz rosettes also signifies growth from a colloidal silica gel at the low temperatures characteristic of surface weathering conditions. Such conditions prevent the growth of large quartz crystals.

Further investigation of these unusual mineral specimens is underway. Still unanswered is the ultimate source of the quartz (it occurs in a limestone) and how long after the initial limestone was lithified into rock the quartz rosettes began to form.

REFERENCES

Root, S. I. (1968), **Geology and Mineral Resources of Southeastern Franklin County, Pennsylvania,** Pennsylvania Geological Survey, 4th ser., Atlas 119cd, p. 30-33.

Sando, W. J. (1957), **Beekmantown Group (Lower Ordovician) Maryland,** Geol. Soc. America Memoir 68, 161 p.

Stose, G. W. (1909), **Description of the Mercersburg-Chambersburg District, Pennsylvania,** U. S. Geol. Survey Atlas, Folio 170, 19 p.

William H. Bolles
Pennsylvania Department of Education

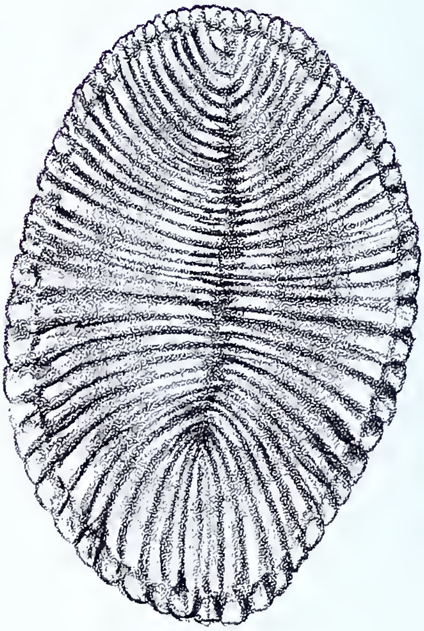
Davis M. Lapham
Pennsylvania Geological Survey

FOSSILS FROM "DOWN UNDER" FOUND IN PENNSYLVANIA

Fossils similar to very ancient "jelly fish" discovered in South Australia have been found in Pennsylvania by Professors Helgi Johnson and Steve Fox, Jr. and students of the Department of Geology of Rutgers, New Brunswick, New Jersey.

The soft-bodied, jelly-fish-like fossils were first found in Australian rocks over 560 million years old. Until the Pennsylvania discovery no other specimens similar to these had been found, The Pennsylvania specimens were found in the Delaware Water Gap in shale layers of the Shawangunk Formation which is 425 million years old.

The new discovery extends the time range of these unusual fossils from before the Cambrian Period to the Silurian Period and in areas from Australia to Eastern North America.



Artist's sketch of "jelly-fish" (Genus Rutgersella) from Pennsylvania

SURVEY ANNOUNCEMENTS

ANNUAL OIL AND GAS REPORT

Progress Report 181, **"Oil and Gas Developments in Pennsylvania in 1969 with Ten-Year Review and Forecast"**, has recently been published by the Pennsylvania Geological Survey. The report is divided into four parts: Part 1, Completion Highlights for 1969; Part 2, Oil and Gas Industry Activity in 1969; Part 3, Summarized Records of Deep Wells Reported in 1969; Part 4, Ten-Year Review and Forecast.

Oil and gas developments in 1969 were highlighted by a number of significant developments. Drilling and production of oil increased 16 and 7 percent, respectively. Production and reserves of gas declined during the year.

A major aspect of the 1969 annual report is the Ten-Year Review and Forecast. Of particular interest is the demonstration of the large volume of untested sediments in Pennsylvania and the projection for continued development of gas reserves and production.

Progress Report 181 may be purchased from the Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125, for $0.70 plus sales tax.

KINZUA REPORT PUBLISHED

The Pennsylvania Geological Survey has just published Bulletin M 62, **"Oil and Gas Geology of the Kinzua Quadrangle"**, by W. S. Lytle and J. H. Goth. This report gives the results of a detailed investigation of the oil and gas resources of the Kinzua quadrangle of Warren and McKean Counties. It shows which formations are productive of oil and gas and what their physical and chemical properties are. Included are a description of the oil and gas fields and a discussion of future oil and gas possibilities of the area.

The report contains descriptions resulting from microscopic examination of each of the reservoir rocks. Average thicknesses of the reservoir rocks and thickness changes from one place to another are shown. The history of the oil and gas industry of the area is reviewed and current activities are noted. Local drilling and production practices are also discussed.

A detailed map of the oil and gas fields shows the locations of over 1600 wells drilled for oil and gas in the Kinzua quadrangle. Other maps show the structures in the quadrangle and the thickness of two of the productive horizons; three detailed cross sections correlate the producing sandstones.

This report will be of use to the oil and gas operator, to the professional geologist, to planners in the area, to highway and construction engineers, and to students of geology and oil and gas history. Oil and gas operators and professional geologists desiring to develop the area, operate secondary recovery projects, or explore for new oil and gas will be able to use large portions of the data to assist their activities. Planners and those engaged in construction will need to know the locations of the active and abandoned wells and will have to be aware of areas where consideration should be given to valuable oil and gas property. Students of geology and oil and gas history will better understand the oil and gas geology of the area and the events during the early days of oil.

The authors conclude that some of the old oil productive areas should be amenable to secondary or tertiary recovery methods and that large areas exist where only limited exploration has taken place. Extension of several of the old oil and gas fields is also possible. It is hoped that this report will stimulate the oil and gas operators to continue to develop and to prospect for new production.

Bulletin M 62 is available for $5.00, plus sales tax, from the Bureau of Publications, P.O. Box 1365, Harrisburg, Pa. 17125.

FRANKLIN COUNTY REPORTS

Two publications dealing with the geology of the carbonate rocks in Franklin County have just been published by the Pennsylvania Geological Survey.

Progress Report 179 by Angelo O'Kuma entitled **Geology of the Carbonate Rocks of Path Valley, Franklin County, Pennsylvania,** shows the distribution of the various formations that comprise the large belt of carbonate rocks in Path Valley in the northwestern part of the county. The carbonate rocks of Ordovician age form a single large anticline faulted on the west side and surrounded by younger shales. This is presented on a geologic map at a scale of 1:62,500. Progress Report 179 is available for $1.20 plus sales tax from the Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125.

Progress Report 180 by John H. Clark entitled **Geology of the Carbonate Rocks in Western Franklin County, Pennsylvania,** includes the geology of an area extending nearly twenty miles north from the Pennsylvania-Maryland boundary. Three belts of carbonate rocks occur in the region. Each belt consists of a complexly faulted anticline of Cambrian to Ordovician carbonate rocks surrounded by younger shale. Some of the faults have displacements of several thousands of feet. The distribution of the various formations, folds, and faults is shown on a geologic map at a scale of 1:24,000. Progress Report 180 is available for $1.50 plus sales tax from the Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125.

Each publication includes a brief text that describes the stratigraphy, structure and economic resources of the area. Some of the Middle Ordovician limestones are quite pure and constitute a valuable mineral resource. These reports should be of interest and use to geologists, planners, mineral producers, and conservationists.

NEW OIL AND GAS BASE MAPS

The Survey's new Oil and Gas Base Map Program (Pennsylvania Geology, Vol. 1 No. 4) has been well received. Demand for the initial four base map areas has exceeded expectations. Since first announcement in the February, 1970 issue of this booklet, initial printing of the base plus field outlines for all four maps was exhausted by the end of May. Because of the popularity of the base plus field outlines, the Survey will limit subsequent printing to this series only.

Six-month updated (posted date June 1, 1970) prints of current bases are now available. In addition, prints of three new base maps can be obtained. Available base maps now include:

Designation	**Quadrangles Encompassed by Mapped Area**
Map 16	Corry, Tidioute, Titusville, Youngsville
Map 17	Kane, Kinzua, Sheffield, Warren
Map 18	Clarion, Foxburg, Oil City, Tionesta
Map 19	Brookville, DuBois, Hallton, Marienville
Map 21	Zelienople, Butler, Sewickley, New Kensington
Map 22	Kittanning, Rural Valley, Freeport, Elders Ridge
Map 23	Smicksburg, Punxsutawney, Indiana, Barnesboro

Paper prints of the bases with field limits can be obtained by writing to the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania 17125. Cost of each map is $0.50, plus state sales tax. A check for the appropriate total amount made out to the Commonwealth of Pennsylvania must accompany the order. When ordering please specify the map number.

An index showing the location of the completed bases may be obtained upon request from the Pittsburgh Branch of the Pennsylvania Geological Survey, 401 Pittsburgh State Office Bldg., 300 Liberty Ave., Pittsburgh, Pa. 15222.

NEW SURVEY PUBLICATIONS

The following list of publications has been released by the Survey during the past few months. All of these publications are available at the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania, 17125. Checks should be made payable to the Commonwealth of Pennsylvania. For Pennsylvania addresses, please add 6% State Sales Tax. For free publications write to the Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg, Pennsylvania.

Publication			*Price*
A	157d	**Geology, Mineral Resources and Environmental Geology of the Palmyra Quadrangle, Lebanon County,** by A. R. Geyer (46 p., 17 figs., 1 pl.).	$ 2.50
C	67	(Reprint) **Geology and Mineral Resources of York County,** by G. W. Stose and A. I. Jonas (195 p., 14 figs., 38 pls.).	10.00
G	59	**Geology of the Pittsburgh Area,** by W. R. Wagner and others (145 p., 65 figs., 4 pls.).	1.00
IC	69	**The Mineral Industry of Pennsylvania in 1968,** by C. C. Yeloushan (22 p., 2 figs.).	Free
Map	20	**Water Yielding Capability of Bedrock Units** (1 sheet 9" x 12" in color)	Free
M	62	**Oil and Gas Geology of the Kinzua Quadrangle,** by W. S. Lytle and J. H. Goth (99 p., 11 figs., 9 pls.).	5.00
M	64	**Proceedings: Fifth Forum on Geology of Industrial Minerals,** edited by K. V. Hoover (278 p.).	2.35
PG	4	**Moraine State Park,** by W. S. Lytle (7 page leaflet, 3 figs.)	Free
PR	179	**Geology of the Carbonate Rocks of Path Valley, Franklin County,** by A. Okuma (1 plate).	1.20
PR	180	**Geology of the Carbonate Rocks in Western Franklin County,** by J. A. Clark (1 plate).	1.50
PR	181	**Oil and Gas Developments in Pennsylvania in 1969, with Ten-Year Review and Forecast,** by D. R. Kelley and others (65 p., 16 figs.).	0.70
W	27	**Ground-Water Resources of the Loysville and Mifflintown Quadrangles, South-Central Pennsylvania,** by H. E. Johnston (96 p., 12 figs., 2 pls.).	3.40

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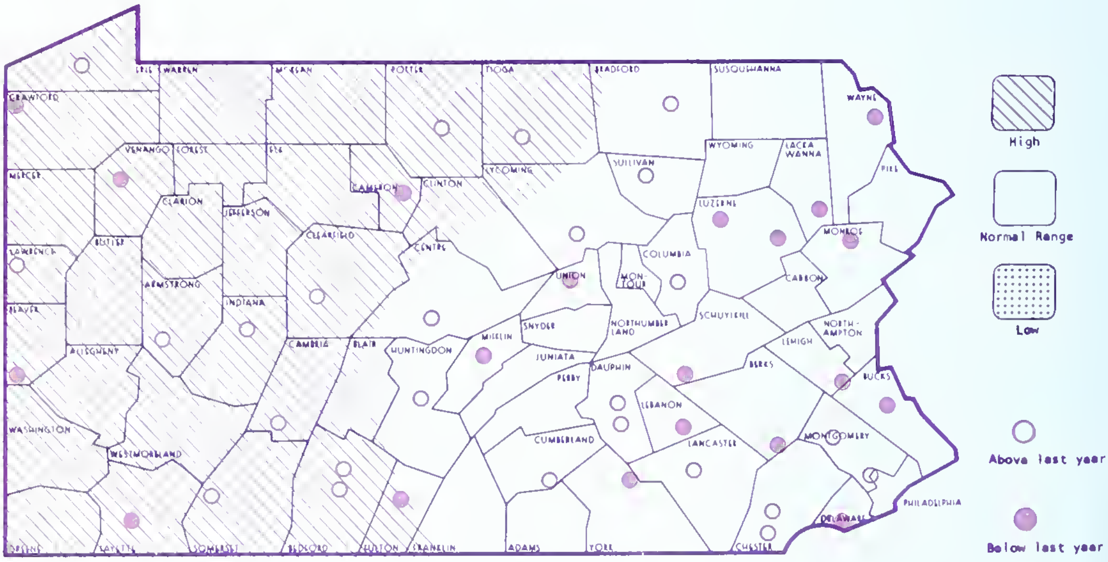
GROUND-WATER LEVELS



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PENNSYLVANIA GEOLOGY

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THE PENNSYLVANIA GEOLOGICAL SURVEY

VOL. 1 NO. 9

COMMONWEALTH OF PENNSYLVANIA
Raymond P. Shafer, Governor

STATE PLANNING BOARD
Irving Hand, Executive Director

Topographic and Geologic Survey
Arthur A. Socolow, State Geologist

CONTENTS

The State Geologist Reports 1
Environmental Study of the Harrisburg Area 2
Southwestern Penna. Environmental Study 6
Award-Winning Paper on Engineering Geology 7
New Fossil Locality for Clearfield County 8
Earth Science Teachers' Corner 10
Calciostrontianite (?) 11
Vandalism Solved by Geological "Detectives" 12
Survey Announcements 13
Limestone Fights Air Pollution 15
New Survey Publications 16

ON THE COVER — View of rockfall along the side of a Pennsylvania highway. This is an example of an environmental geology problem which can be predicted by advance studies of the environmental geology of an area.

PENNSYLVANIA GEOLOGY is published bimonthly by the Topographic and Geologic Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

DECEMBER 1970

FROM THE DESK
OF THE
STATE GEOLOGIST . . .

METROPOLITAN ENVIRONMENTAL STUDIES

Environmental geology studies of two of Pennsylvania's metropolitan areas are discussed in this bulletin. A progress report is presented on the Pennsylvania Geological Survey's project in the Greater Harrisburg Area, and the approval of a comprehensive environmental study for the Greater Pittsburgh Area is announced. The latter is to be a cooperative state-federal project.

It is well to note that the involvement of geologists and geological surveys with the environment is not new, faddish, or an attempt to cash in on the trend of the moment. Geology by its definition, the science of the earth, has always been an environmental science. Geologists by their studies of the forms and processes on the earth's surface have long been engaged in environmental research. What has changed, however, is that the rest of our society has been awakening to the importance and to the mistreatment of our environment. And as more people in all walks of life begin to involve themselves with the environment, they are recognizing and utilizing geology more and more as a vital component in environmental planning and protection.

As geologic surveys have taken on more and more formally designated environmental studies, some concern has been expressed that the surveys may begin to neglect basic geologic mapping and fundamental geologic research. That should not and must not be allowed to happen. In order to carry out a comprehensive environmental geologic study of any given area, it is essential that there first be completed the basic geologic mapping, mineral resources investigations, and water resources studies. It is after these basic data are accumulated that their relationship and impact on man's activities can be considered. That is what the new trend in environmental geology is all about - relating basic scientific data and knowledge to man and his environment.

The Pennsylvania Geological Survey is pleased that the citizens of Pennsylvania, as well as other state and local agencies, are becoming aware of the geologic aspects of environmental planning. We are striving to meet the new needs and demands, even as we shall continue to carry out the basic geologic mapping and research from which environmental geologic projects can be carried to fruition.

Arthur A. Socolow

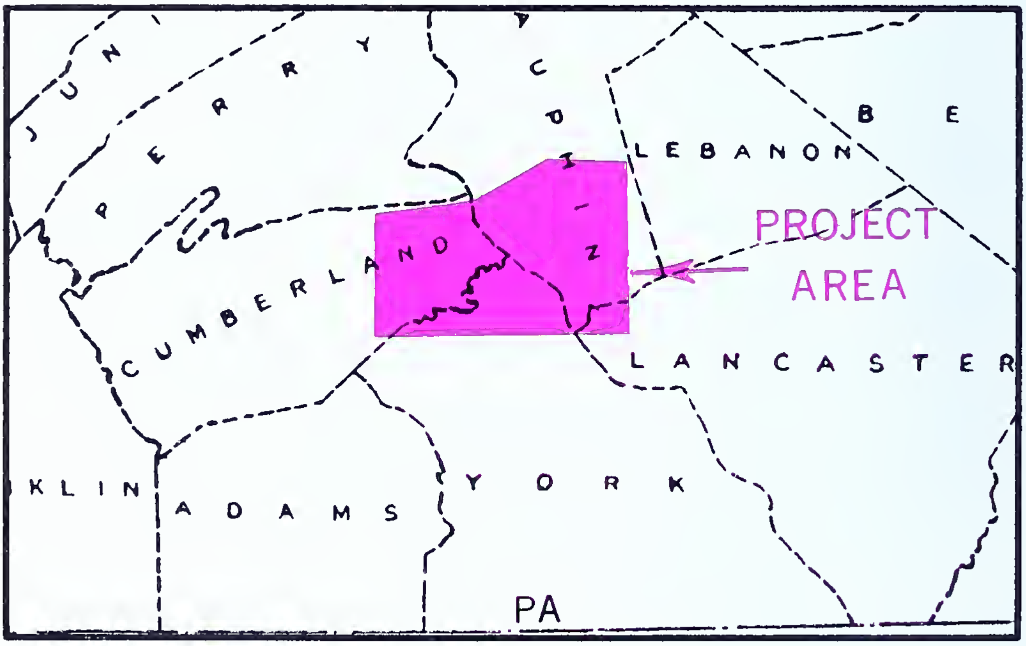
ENVIRONMENTAL STUDY OF THE HARRISBURG AREA

ENVIRONMENTAL GEOLOGY IS THE APPLICATION OF GEOLOGY TO MAN IN HIS ENVIRONMENT

The Pennsylvania Geological Survey has initiated a new kind of geological study for the most heavily populated portion of the Harrisburg Metropolitan Area. Planners estimate that by 1997 an increase of 74 percent in population will occur in the Harrisburg area. The major portion of this increase will take place along an east-west belt in the central portion of the project area. Concurrently, industrial growth will accelerate, and housing, water and transportation demands will proliferate as well as many other requirements. All of this growth will place a formidable strain on the available land, water resources and mineral resources.

The area of interest covers approximately 325 square miles in Cumberland, Dauphin, and York Counties with the city of Harrisburg in the key, central position.

The purpose of this new study by the Pennsylvania Geological Survey is to apply geological principles, interpretations and data toward an understanding of the project area that will be immediately useful to planners, engineers, government officials and the general public.



HARRISBURG PROJECT AREA

Much of the geologic and water resource information is presently available in Pennsylvania Geological Survey publications, unpublished material and other sources. Additional basic investigations are being undertaken to supplement the existing information; new, different types of interpretations and maps will be derived from the compiled data. Advice and information will be gathered from local governmental and planning organizations and appropriate state and federal agencies.

PARTS OF STUDY

The four main parts of the study are:

BASIC GEOLOGY	**MINERAL RESOURCES**
GROUND WATER RESOURCES	**ENGINEERING GEOLOGY**

These main sections and their component parts will be related to application. Illustrations and photos will be included in the report to demonstrate principles and geologic conditions as they affect man and his environment.

Listed below are brief discussions of the four main parts of this report:

BASIC GEOLOGY

Important characteristics of the rocks include such descriptive information as: type of rock, reaction of rock to weathering, thickness of layers, attitude (dip) of rock layers, frequency, size, shape and orientation of rock fractures, relation of topographic forms (relief) to rocks and others.

PROMINENT FRACTURES
IN TOUGH DIABASE ROCK

PINNACLE WEATHERING IN
SOLUBLE LIMESTONE

The distribution of various rock types is shown on the geologic map, which is a key tool in geologic investigations. The geologic map will show the type of rock and its structural characteristics for any location in the greater Harrisburg area.

USE - basic geologic data for engineering geology application, to determine ground-water availability, foundation characteristics of rocks, prospective sites for solid waste disposal, mineral occurrences and many others.

GROUND-WATER RESOURCES

Ground-water is the water stored in rocks below the surface of the earth. The information to be obtained and compiled for this report includes: location of selected water wells, depths of wells, range and average yields of wells, depth to water, additional producing characteristics of the water-bearing rocks, quality of water and others.

PRODUCING WATER WELL

USE - evaluation of individual aquifers (water-bearing rocks), determination of ground-water availability in an area, optimum depth for wells, optimum topographic setting for well site, recharge potential of aquifers, sensitivity to pollution, partial evaluation of solid waste disposal sites and others.

MINERAL RESOURCES

Distributions and descriptions of mineral resources are to be presented. Data compiled includes depths to mineral deposits; size, shape and quantity (reserves) of specific mineral commodities; quality and ultimate value of mineral deposits, relationships of mineral resources to adjacent rocks and others.

PRIMARY USE IS
EXCAVATION OF MINERAL

SECONDARY USE IS
WATER SUPPLY

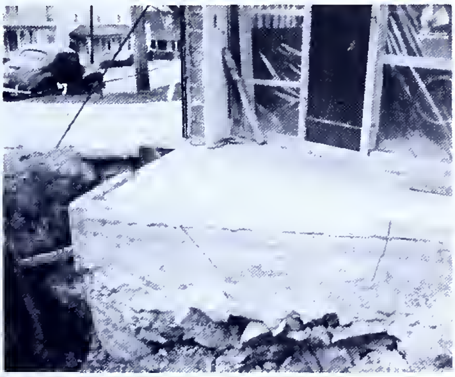
USE - Planning - Planners and government officials with prior knowledge and appreciation of mineral deposits can plan to have industry extract all or part of the resource before developing and building upon the area - priorities can be established - the ultimate, total value of the mineral resource can be determined. The multiple use concept can be effectively used if precise mineral data is available *at the beginning* of planning; for example -

OTHER SECONDARY USE-
SANITARY LANDFILL

QUARRY $\underline{\text{to}}$ SANITARY LANDFILL $\underline{\text{to}}$ RECREATION AREA

ENGINEERING GEOLOGY

The geologic conditions which affect engineering works are to be considered in this portion of the report. Information to be developed includes depth to bedrock, condition of rock mass, cut-slope stability of rocks, foundation stability, excavation characteristics of rocks and physical tests such as compressive strength, shear strength, porosity and others.

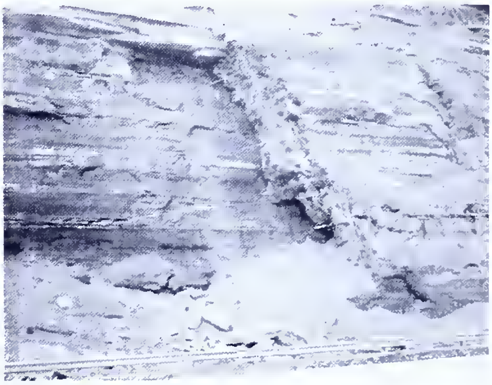


FOUNDATION FAILURE
IN LIMESTONE SINKHOLE

USE - The engineering geology information is used in the planning, design and construction of engineering works and affects safety, construction efficiency and economics.

USE - Involved in the evaluation of solid waste disposal sites and subsurface liquid waste disposal wells. Involved in the recognition of, modification of or correction of "geologic hazards" which are produced by man's alteration of his natural environment.

The environmental geology study of the Harrisburg Metropolitan Area is scheduled for completion late in the summer of 1971 and will be made available to all interested persons.



ROCKFALLS ALONG ROAD

William G. McGlade

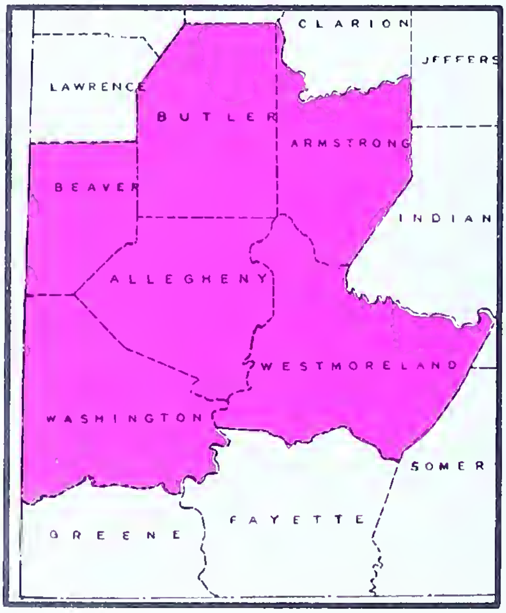
SOUTHWESTERN PENNA. ENVIRONMENTAL STUDY

The Southwestern Pennsylvania region, centering on Pittsburgh, is one of the six metropolitan areas in the United States which have been designated by the United States Department of the Interior for a comprehensive study of environmental and resource factors affecting growth and redevelopment. The four-year project will be conducted jointly by the United States Geological Survey and the Pennsylvania Topographic and Geologic Survey. Federal funds will cover 85% of the total project cost of nearly two million dollars. The detailed project work will be carried out by staff members of the U. S. Geological Survey, the Pennsylvania Geological Survey, and by contract with the private sector.

The growth of metropolitan areas is greatly controlled by their land and water resources. A detailed evaluation and inventory of those physical resources is necessary for long-range planning and effective decision making.

The new Southwestern Pennsylvania Environmental Study will cover the six counties of Allegheny, Armstrong, Beaver, Butler, Washington, and Westmoreland. This is an area faced with many special environmental problems, such as landslides on unstable slopes, subsidence related to mined-out areas, water pollution by industrial wastes and acid mine water, flash floods, and limited construction resources. The goal of the environmental study will be to define those and other factors needed to plan for housing, industrial development, waste disposal, transportation networks, and recreation facilities.

The Southwestern Pennsylvania Environmental Resources Study is to be a practical demonstration of the role of geology in planning for wise land use and environmental protection.



SOUTHWESTERN
PENNSYLVANIA
ENVIRONMENTAL
STUDY AREA

AWARD-WINNING PAPER ON ENGINEERING GEOLOGY

Peter Wilshusen of the Pennsylvania Geological Survey was awarded first prize for his paper on *Engineering Characteristics of The Rocks of Pennsylvania,* presented at the Meeting of the Association of Engineering Geologists. The paper was among 37 others presented during the technical sessions in Washington, D. C. in the week of October 18. More than 300 geologists attended the meetings to discuss problems having to do with the application of geology to engineering practice.

Engineering geologists are concerned with the relationship of rock and soil conditions to the design, construction and maintenance of highways, bridges, buildings, dams and other engineering structures. If a highway is to cross a limestone terrain filled with solution cavities, caves and sink holes, an engineering geologist will have provided information so the road can be safely built. If a large earth fill dam is to be built, an engineering geologist will have studied the foundation so it can be treated against leakage beneath the embankment. These two examples show the importance of this often unseen work to the satisfactory completion of large construction projects.

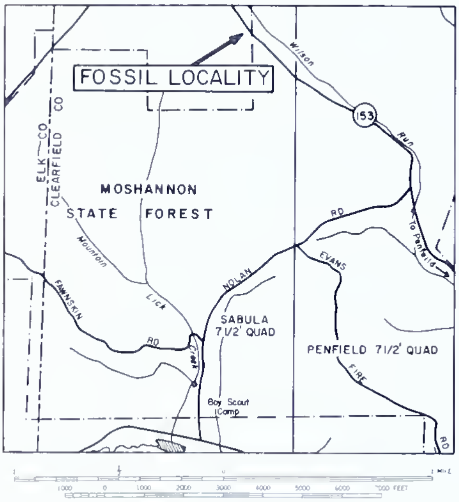
Mr. Wilshusen outlined the results of a study underway by the Pennsylvania Geological Survey in which rock characteristics important to the engineer, designer, contractor, planner and consultant are being described for rock units across the State. Questions to be answered by the study are: 1. What are the materials to be dealt with and what is their condition? 2. How do they react to stress? 3. What is the degree of permeability? 4. Does a site contain construction materials for the proposed project or of economic value outside the project? 5. What groundwater conditions can be expected? 6. What earth processes, such as flooding, are active? 7. How stable is the land? We are providing some answers to these questions through a group effort of Survey staff members who are gathering pertinent geologic information. The first results are to be published soon.

PENNSYLVANIAN HEADS BUREAU OF MINES

Dr. Elburt F. Osborn was sworn in on October 23 as the 13th Director of the United States Bureau of Mines. Dr. Osborn was formerly Dean of the College of Mineral Industries at the Pennsylvania State University and more recently served as Vice President for Research at the University. The Pennsylvania Geological Survey congratulates its fellow Pennsylvanian and fellow geologist upon this most important appointment.

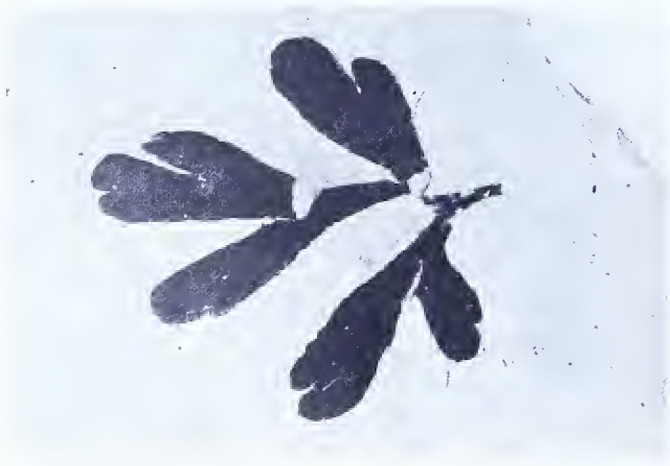
NEW FOSSIL LOCALITY FOR CLEARFIELD COUNTY

A fascinating variety of Mississippian fossils is available for both amateur and professional paleontologists, as well as any lay naturalist who wishes to step back about 325 million years into the past. In the extreme northwestern corner of Clearfield County, shales, siltstones, and sandstones in a borrow pit in the middle part of the Pocono Formation yield plant and invertebrate fossils along with a few vertebrate fragments.



The borrow pit is located on the southwestern side of Pennsylvania Route 153 on Boone Mountain, about 4.1 miles northwest of the village of Penfield. There is ample parking space for a few cars opposite the large road cut just northwest of the borrow area, on the northeastern side of the road. Collectors must use this parking space and walk carefully back to the site, using caution and common sense with regard to traffic.

At least two Mississippian plant genera, *Adiantites* and *Lepidodendropsis,* may be collected from the greenish siltstone and sandstone rubble at the base of the borrow pit face. Well-preserved, partly carbonaceous, impressions of plant stems up to three inches wide have been found. Careful searching in some of the finer-grained, shaly units will reveal beautifully-preserved leaves. Some excellent specimens have been collected from the road cuts to the northwest of this borrow area.



MISSISSIPPIAN PLANT FOSSIL
ADIANTITES SPECTABILIS

MISSISSIPPIAN
PLANT FOSSIL

Abundant molds of Mississippian brachiopods with some pelecypods, crinoid columnals, and rare bryozoans occur in patches in the layers that form the floor of the pit. Occasional, small, fish bone fragments will catch the eye of the careful observer; they are bluish-white and display bony structure when examined with a hand lens. Common brachiopod genera are *Rhipidomella, Spirifer, Camarotoechia,* and *Productus;* an occasional large *Orbiculoidea* may be found. The pelecypod *Cypricardinia* has been tentatively identified at this locality.

The fossils were included in deposition of the middle portion of the Pocono Formation — part of a deltaic complex that extended over much of central Pennsylvania during the Mississippian Period. Land plants were common during this time and were forerunners of those that formed the great coal swamps of the Pennsylvanian Period. The marine invertebrates were obviously prolific in the delta front muds and sands.

MISSISSIPIAN BRACHIOPODS

Thomas M. Berg

PROLIFIC GASOLINE FIELD

In the October 1969 issue of *PENNSYLVANIA GEOLOGY,* we reported on the occurrence of subsurface gasoline floating on the water table of a limestone terrain in Hampden Township, just across the Susquehanna River from Harrisburg. At that time 112,000 gallons of gasoline had been pumped from 35 wells which had been drilled in the one square mile area for recovery purposes.

During the past year tests and examinations have been carried out on the near-by pipelines and gasoline storage tanks, without any success in locating the specific source of the gasoline. Meanwhile, pumping has continued to recover the gasoline. It has been found that five or six of the wells are the major producers; indications are that these wells lie along a major fracture trace along which the gasoline tends to concentrate. It is also noteworthy, that the recovery rate per well per day tends to decrease as the water table rises, suggesting that with a higher water table the gasoline spreads out beyond the fracture.

As of November 15, 1970, there has been recovered from this little "gasoline field" 208,296 gallons of quality, usable gasoline!

EARTH SCIENCE TEACHERS' CORNER

U. S. GEOLOGICAL SURVEY'S LEAFLET SERIES

Several new titles have been added to the U.S.G.S. list of popular geology leaflets and booklets:

"Geologic Maps of the Moon", 4p. leaflet.
"Use and Conservation of Minerals", 4p. leaflet.
"Natural Steam for Power", 10p. leaflet.
"Collecting Rocks", 8p. leaflet.
"U. S. Geological Survey Library", 4p. leaflet.
"The Geologic Setting of the John Day Country", 23p. booklet.
"John Wesley Powell, Soldier, Explorer, Scientist", 23p. booklet.
"Geologic Time", 20p. booklet.
River Basins of the United States - Series
  The Delaware, 4p. folder.
  The Columbia, 4p. folder.
  The Hudson, 4p. folder.
  The Potomac, 4p. folder.

All of the above publications are available from the U. S. Geological Survey, Distribution Section, 1200 South Eads Street, Arlington, Virginia 22202, free of charge.

STEREOGRAM BOOK OF ROCKS, MINERALS AND GEMS

Hubbard Press has recently published a stereogram book of 159 full-color rock, mineral, and gem photos in matched pairs for stereo viewing. This book with the aid of a stereoscope enables the reader to study these rocks, minerals, gems, lunar rocks and crystal systems in three dimensions. Sample pages of the book are available for examination from Hubbard Press, 2855 Shermer Road, Northbrook, Illinois 60062.

ENVIRONMENTAL STUDIES NEWSLETTER

An Environmental Studies (ES) Project is currently underway in Boulder, Colorado. The project directors, Drs. William D. Romey and Robert E. Samples, say this project represents a pioneer effort to develop materials for teachers that will allow the student to express himself regarding the immediate environment in which he lives. A major distinction of this program is that three environments are considered. The first is the inner environment of the child. The second is the immediate environment in which he lives, and the third is the global environment which is of so much concern to mankind.

Because Environmental Studies is nondisciplinary and usable in a wide variety of content areas, teachers in nonscience as well as science fields may be interested in the materials. If your name is not on their regular NEWSLETTER mailing list or if you know of someone who would like to receive news on the progress of the Environmental Studies program, write your name on a postcard and send it to — NEWSLETTER, Environmental Studies Program, Box 1559, Boulder, Colorado 80302.

CALCIOSTRONTIANITE (?)

At Winfield, Union County, Pennsylvania there is a quarry in Keyser limestone that has become well known as a mineral-collecting locality (see Pa. Geol. Survey Bulletin G-33, "Mineral Collecting In Pennsylvania"). Many fine mineral specimens from this quarry have found their way into collections throughout the northeastern United States. Of particular interest have been the fluorescent aragonite, celestite, and "strontianite".

It is this latter mineral, strontianite, that is now in question. Originally, this mineral was identified as aragonite on the basis of crystal form. Subsequent chemical testing showed that strontium was the dominant element. An x-ray pattern confirmed that aragonite was incorrect and an almost perfect match was obtained with standard x-ray patterns for strontianite. However, this may not yet be the final truth of this seemingly elusive mineral occurrence. Some work done by R. V. Dietrich (American Mineralogist, 1960, p. 1119 - 1124) on similar occurrences in Virginia has come to our attention. Dr. Dietrich found that some strontianite-like minerals contained as much as 8.1% CaO and that the x-ray pattern of this material differed very slightly from that of pure strontianite (strontium carbonate with no calcium). He designated this mineral calciostrontianite.

The x-ray patterns of the Winfield "strontianite" have been re-checked and fit more closely that of calciostrontianite than that of strontianite. Although a chemical analysis for calcium should be made before positive identification is concluded, calciostrontianite is presently the more likely name for this Winfield mineral. Those of you who have this mineral in your collection should place a question mark after the name, either calciostrontianite (?) or strontianite (?). Those collectors who do not have good specimens should try to obtain them. Calciostrontianite, even with a question mark, is an unusual mineral.

D. M. Lapham

VANDALISM SOLVED BY GEOLOGICAL "DETECTIVES"

Geological knowledge and methods are not usually considered to be typical crime-solving tools. Nevertheless, rocks can be potent weapons and geologists can become involved in criminal detection. A case in point was the problem recently submitted to, and solved by, the Pennsylvania Geological Survey.

The Industrial Development Department of the Penn Central Transportation Co. submitted two rock samples to the Survey with the following problem. New automobiles from Detroit were arriving in New Jersey with smashed windows, dents, and scars resulting from rocks thrown at the passing railroad cars. The problem was whether, from an examination of the rocks found in the automobiles, we could identify the location of the vandalism, so that concentrated policing procedures could be initiated. Obviously, the whole length of track between Michigan and New Jersey could not be policed. In addition, there were two routes that could have been used to transport the automobiles, one through New York State and one through Pennsylvania, making any policing job even more difficult.

Along those two railroad routes there is an incredible variety of rock types and many of them can be found at several different places along the two routes. Here though, we had a bit of luck. The rocks that caused the damage were examined microscopically in the Pennsylvania Geological Survey laboratory. Both were found to be a coarse-grained (pegmatatic) gneiss containing feldspar, quartz, biotite mica, chlorite, and slender crystals, probably of the mineral called apatite. These minerals and the rock texture provided the critical clue that the rock specimens were from a metamorphic terrain.

The mineralogy of the rock samples permitted the search to be narrowed to southeastern New York and Pennsylvania. These areas, known as the Reading Prong in New York and the Piedmont in Pennsylvania, both contain metamorphic rocks. Could the Survey narrow the problem area further? We thought so. The rock type of the thrown samples occurs along the Penn Central Railroad in Pennsylvania, but there it usually has less biotite and almost never any apatite. On the other hand, rocks containing these minerals are common in a limited area of southeastern New York State. Therefore, we suggested that the most likely source of the thrown rocks would be along a stretch of tracks in the vicinity of West Point, north of New York City. This was confirmed by Penn Central's own geologists in an independent study of only the northern route.

The results are now in. Policing action by the Penn Central Railroad was initiated in the West Point area. Sure enough, several of the culprits were spotted there in action, and appropriate measures were taken by the railroad. Case closed.

SURVEY ANNOUNCEMENTS

REPORT ON THE PALMYRA AREA GEOLOGY

The Bureau of Topographic and Geologic Survey has released a new publication, "Geology, Mineral Resources, and Environmental Geology of the Palmyra Quadrangle, Lebanon and Dauphin Counties", by Alan R. Geyer.

In this report particular attention has been given to the effect upon the environment and land use by the properties and distribution of the various rock and mineral resources. The geologic map is particularly keyed to show the engineering properties and groundwater availability for each of the rock formations; difficult foundation conditions, potential cave-in sites, and excavation properties are identified for the entire area.

The Palmyra Quadrangle area is one of complex geologic conditions with a number of valuable mineral resources. The high-calcium limestone of the area is widely used for fluxstone, agricultural lime, cement manufacture, filler material and construction stone. The new publication details the chemical and physical properties of this valuable limestone, as well as its distribution and reserve potential. The shale formations of the area which are valuable for brick manufacture and light-weight aggregate are also described in detail.

The new report on the geology of the Palmyra Quadrangle will be of interest and benefit to the residents, planners, industrial developers, and all who are interested in wise land use and our environment.

Bulletin A-157D, Geology, Mineral Resources and Environmental Geology of the Palmyra Quadrangle, Lebanon and Dauphin Counties, is available from the Bureau of Publications, P. O. Box 1365, Harrisburg, Pa. 17125, for $2.50 plus sales tax:

NEW ATLAS OF METAL MINES AND OCCURENCES

The Pennsylvania Geological Survey has published *Metal Mines and Occurrences* as Part 3 of the Atlas of Pennsylvania's Mineral Resources. Authored by Professor Arthur W. Rose, this new bulletin is an important step in identifying and evaluating the economic potential of the Commonwealth's metallic mineral industry.

Metallic mineral resources are in ever-increasing demand. Those which were easily found at the surface were developed early in Pennsylvania's industrial history. While the Commonwealth once had thousands of metal mines in production, most have been exhausted or are too small to compete in today's market where only large-tonnage deposits are economically minable.

Some of the old areas may hold the key to future mining in Pennsylvania. As foreign sources become less available, as demand continues to grow, and as technology advances to allow the exploitation of deposits of lower grade, old mining areas and low-grade deposits may have new potential for economic development. Thus, *Metal Mines and Occurrences* can serve as an aid in the re-examination of the economic potential of mineral occurrences in Pennsylvania.

The new publication contains 14 pages of text, two tables, and a map all in a section form that can be added to the previous M-50 Atlas publications on limestone and clay resources in Pennsylvania. All metal occurrences except residual iron oxide deposits and magnetite in metamorphic rocks are included. A total of 371 mineral localities are plotted on the map and described in the text. Information given includes production figures, history, and a summary of the geology. The deposits are classified primarily by the age of the host rocks that the metals replace and secondarily by geologic type. The list of 93 references will prove useful to geologists and mining engineers seeking more detailed information.

Production from these metallic deposits has totaled more than a billion dollars (at 1968 prices) to date. As the new publication makes clear, the future in Pennsylvania looks promising, especially for iron and zinc. Known occurrences of copper, lead, nickel, and uranium also merit consideration for the future.

This publication also will be useful to economic geologists interested in the origin of large ore provinces, to compilers of nation-wide resource estimates, and to planners or developers interested in the value and potential of land for development. Because mining is an exploitation of the land, this publication also should be of importance to conservationists and all those concerned with the quality of our environment.

Metal Mines and Occurrences, Part 3 of Bulletin M-50, Atlas of Pennsylvania's Mineral Resources, may be obtained from the Bureau of Publications, P. O. Box 1365 Harrisburg, Pa. 17125, for $1.60 plus sales tax.

STRATIGRAPHIC OFFICER

Pennsylvania State Geologist Arthur A. Socolow has been elected as Vice Chairman of the American Commission on Stratigraphic Nomenclature.

LIMESTONE FIGHTS AIR POLLUTION

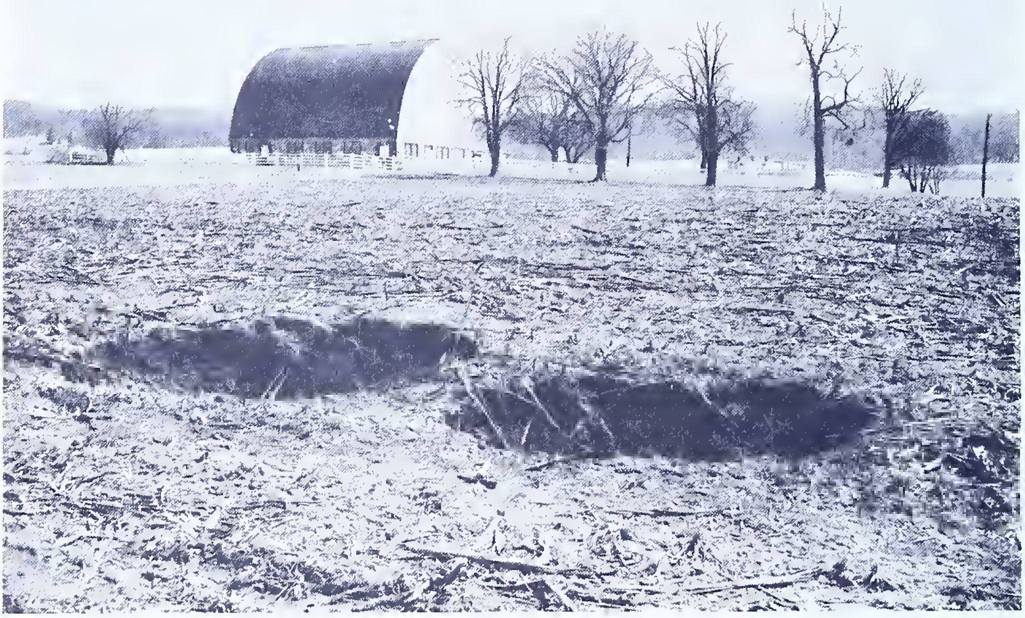
Investigations in progress by the United States Bureau of Mines and several other organizations indicate that ground limestone used in coal fired electric plants may permit the use of high sulfur fuel without air pollution from sulfur oxides. In this process ground limestone is introduced into the combustion area where it is calcined. The resulting hot lime reacts with sulfur oxides from burning coal to produce solid particles of calcium sulphate which are recovered with the fly ash. Experiments with various rocks indicate that the fineness and porosity of the calcined lime is the principal factor controlling the efficiency of sulfur scavenging. Magnesian or dolomitic limestones appear to be as effective as more purely calcic varieties of limestone.

The economic and technologic feasibility of this process in large scale power plants has yet to be demonstrated, but if it is successfully established, it would have substantial impact on major sectors of the Pennsylvania mineral industry. Many of the coals presently mined in Pennsylvania contain more sulfur than is approved by current air pollution control standards in urban areas, and it can be presumed that these standards may become more stringent and widespread. As a major portion of these coals are used for power generation, it is obvious that technology for the safe utilization of higher sulfur coals will have a significant benefit to the Pennsylvania coal industry. Extensive development of limestone consumption by the electric power industry would be an entirely new market for limestone producers.

Continuing changes may be anticipated in power generation and transmission technology which will influence the relative costs of minemouth versus near user steam plants, but present indications are that in many cases power can most economically be generated close to the users. The principal external cost of power sites in or near urban areas is air pollution control of sulfur oxides. More economic control of such pollution may significantly alter the options of regional planners.

Southeastern and central Pennsylvania communities are generally fairly well situated with respect to limestone sources which would probably be suitable for sulfur control. Unplanned urban expansion, however, has already eliminated certain sources of limestone supply and threatens others. Where regional planning has been undertaken, it is generally recognized that certain areas must be reserved for the quarrying of construction materials. Limestone for sulfur control represents simply another demand on the same resources. It cannot presently be anticipated what the extent of this demand may prove to be. The significant point for planning is that planners must not only project existing demands to future needs, but must make allowance for technological changes which will affect demands.

D. B. MacLachlan



Two new sinkhole collapses recently appeared in a Lebanon Valley farm field underlain by limestone. This is another example of the impact of geology upon man's activities.

NEW SURVEY PUBLICATIONS

The following list of publications has been released by the Survey during the past few months. All of these publications are available at the Pennsylvania Bureau of Publications, P. O. Box 1365, Harrisburg, Pennsylvania, 17125. Checks should be made payable to the Commonwealth of Pennsylvania. For Pennsylvania addresses, please add 6% State Sales Tax. For free publications write to the Pennsylvania Geological Survey, Main Capitol Annex, Harrisburg, Pennsylvania, 17120.

Publication			*Price*
A	223	**Geology and Mineral Resources of the Pennsylvania Portions of the Milford and Port Jervis 15′ Quadrangles,** by F. W. Fletcher and D. L. Woodrow, (64 p., 9 figs., 2 pls.)	$2.10
IC	68	**Chemical Analyses of Three Triassic (?) Diabase Dikes in Pennsylvania,** by D. M. Lapham and T. E. Saylor (16 p., 2 figs.)	Free
M	50	**Part 3 Metal Mines and Occurrences in Pennsylvania,** by A. W. Rose (14 p., 1 pl. in loose leaf folio)	1.60
Pennsylvania Geological Publications, October 1970, prepared by the Bureau of Topotraphic and Geologic Survey (60 p.)			Free

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